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SUMMARIES. SOLID WASTES DEMONSTRATION GRANT PROJECTS, 1969, FOR GRANTS AWARDED DURING THE PERIOD JUNE 1, 1969-DECEMBER 31, 1968

Charles E. Sponagle

Bureau of Solid Waste Management
Rockville, Maryland

1969

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SUMMARIES
solid wastes demonstration grant projects 1969

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solid wastes demonstration grant projects
1969

FOR GRANTS AWARDED DURING THE PERIOD
JUNE 1, 1966—DECEMBER 31, 1968

This report (SW-3d) was prepared by
CHARLES E. SPONAGLE
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U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Public Health Service
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Foreword

THE SOLID WASTE DISPOSAL ACT OF 1965, Title II of Public Law 89–272, directed the Secretary of the Department of Health, Education, and Welfare to initiate a national research and development program for new and improved methods of proper and economic solid waste disposal and to provide technical and financial assistance to State and local governments and interstate agencies in the planning development, and conduct of solid waste programs.*

The Bureau of Solid Waste Management carries out these directives. Major responsibilities of the Bureau include: (1) conduct and support of research on the nature and scope of the solid waste problem, on methods of more safely and efficiently collecting and disposing of solid wastes, and on techniques for recovering from solid wastes potentially valuable materials and energy; (2) provision of training and financial and technical assistance to local and State agencies to survey their needs in the solid waste area and to plan for the development and staffing of programs capable of meeting both present and future requirements; and (3) encouragement and support of projects that may demonstrate new and improved methods of solid waste collection, handling, and disposal. The latter involves provision of grant support for the following types of projects:

1. A demonstration relating to the development and application of new and improved solid waste disposal methods, devices, or techniques.

2. A study and investigation of municipal or regional solid waste disposal practices, procedures, and programs that may:
    a. provide solutions for regional or national solid waste disposal problems, or
    b. lead to a demonstration of improved disposal practices.

3. A study and investigation of a particular solid waste or solid waste disposal problem, practice, or technique, the findings of which will be of significant national value.

The Division of Demonstration Operations has been established within the Bureau of Solid Waste Management to implement this responsibility. Its principal functions include: advice concerning development of new applications; technical review of new applications; continuous monitoring of funded grant projects (consisting principally of provision of technical assistance to grantees, review and evaluation of the project's progress in attaining objectives, and ensuring that appropriate Federal requirements are met); dissemination of information resulting from funded projects; and development of required administrative and fiscal procedures.

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* The Act directs the Secretary of the Department of the Interior to carry out a similar program relating to solid waste disposal problems that are caused by, and can be dealt with as part of, the extraction, processing, or utilization of minerals or fossil fuels.

This publication *(SW–3d)* has been prepared to disseminate concise up-to-date information concerning projects that received demonstration grant support before January 1, 1969. It is hoped that this information will be useful to those working in the solid waste field, will lead to productive interchanges between those having similar solid wastes problems, and will permit the widespread application of new and improved solid waste techniques that are being demonstrated by many of these projects.

—Richard D. Vaughan, *Director*
Bureau of Solid Waste Management

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Introduction

THE PRINCIPAL FEATURES of projects that received demonstration grant support from the Bureau of Solid Waste Management before January 1, 1969, are summarized herein. These summaries update to December 31, 1968, the information for projects appearing in Public Health Service Publication No. 1821, *Summaries of Solid Wastes Demonstration Grant Projects—1968*, and in the publication *Solid Wastes Demonstration Grant Abstracts; Grants Awarded January 1–June 30, 1968*. A new project for the only new grant awarded between June 30 and December 31, 1968, is also included. Annual revision and publication of these summaries is anticipated. Abstracts will be issued periodically for new projects funded in the interval between publication of these summaries.

Trade names are used in this publication solely to provide specific information. Mention of commercial products does not imply endorsement by the U.S. Public Health Service.

Organization of Summaries

Each project is identified by title, type, and grant number. The grantee, project director, cost, and duration of the project is shown. Objectives, procedures, a brief statement of progress, and publications resulting from or concerning the project then follow to complete each summary.

The following is a glossary of terms found in each summary:

PROJECT TYPE: Each project is identified as a "Demonstration" or a "Study and Investigation" in accordance with categories described in the preface.

GRANT NUMBER: The Bureau of Solid Waste Management's identifying number for the project. This should be used in all contacts with the Bureau concerning the project.

GRANTEE: The recipient of the grant support. Grantees may be State, interstate, or local agencies of government, or public or private nonprofit organizations.

PROJECT DIRECTOR: The person designated by the grantee as having primary responsibility for conduct of the project.

ESTIMATED TOTAL PROJECT COST: The estimated total cost of the project over the entire project life.

GRANTEE'S SHARE: That portion of the estimated total project cost that will be borne by the grantee.

FEDERAL SHARE: That portion of the total estimated project cost that may be made available to the grantee as Federal grant support.

Grant funds are committed to a project on an annual basis. For example, a project that will take 3 years to complete may receive the total Federal share in three annual increments, as indicated by the [01], [02], and [03] designations appended to the "Federal Share" amounts.

DATE PROJECT STARTED: The authorized beginning date of the project.

DATE PROJECT ENDS: The date by which the project will be completed. When circumstances warrant, a time extension beyond the original completion date may be authorized by the Bureau of Solid Waste Management.

PUBLICATION(S): Final reports on solid wastes demonstration grant projects, published as Public Health Service Publications, are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Interim reports, published in limited quantities by the Bureau, are available in single copies as supplies permit. Request from the Bureau of Solid Waste Management, 5555 Ridge Avenue, Cincinnati, Ohio 45213.

Acknowledgments

Information used to prepare this publication was furnished by the Project Directors listed herein.

Personnel of the Division of Demonstration Operations who contributed to the preparation of this publication were: Peter R. Johnson, staff engineer, who verified much of the introductory information for each summary and prepared initial drafts of certain summaries; drafts of other summaries were prepared by Project Officers R. Kent Anderson, Jay A. Campbell, Stanley J. Endlich, Dennis A. Huebner, Peter T. McGarry, Charles E. Orr, David E. Ross, and Daniel S. Shiel. The manuscript copy was prepared by Mrs. Dorothy Mills.

Bagged solid wastes landfill project

PROJECT TYPE: DEMONSTRATION GRANT NO. D01–UI–00003
GRANTEE: TOWN OF BARRINGTON
PROJECT DIRECTOR: CALVIN A. CANNEY, TOWN MANAGER, 283 COUNTY ROAD,
BARRINGTON, RHODE ISLAND 02806
ESTIMATED TOTAL PROJECT COST: $279,917
GRANTEE'S SHARE: $ 93,306
(BY YEAR OF PROJECT LIFE) $ 20,522 [01]
$ 62,259 [02]
$103,800 [03]
DATE PROJECT STARTED: JUNE 1, 1966 DATE PROJECT ENDS: MAY 31, 1969

OBJECTIVES: To demonstrate the advantages of a new method of solid waste storage and collection by conducting a project to evaluate the feasibility and economics of combined collection and disposal of rubbish and garbage using kraft paper refuse sacks, and to determine the effect of this collection method on the capacity of a sanitary landfill.

PROCEDURES: The project will be carried out by town employees and supervisory personnel.

Approximately one-third of the community will be converted to the bag system during each year of the project. Costs of initiating and operating the system and public acceptance of the changed collection method will be evaluated. A model sanitary landfill operation will be instituted, and space requirements in relation to this method of collection determined.

PROGRESS TO DATE: Various aspects of the bag system, products, and companies were investigated; and holders and bags were purchased from the St. Regis Paper Company under a 3-yr contract. On the basis of its investigations, the town decided to use a stand-type holder for the bags, with a drop lid and gasket, to allow the householder flexibility in placing the unit.

Prior to initiation of the system, information was released to the press concerning the proposed bag system. In addition, an information packet was mailed to each householder explaining the nature of the proposed system. Conversion of one-third of the town to the bag system was effected by Sept. 28, 1966. An additional one-third of the town was converted to the bag system in the second year of the project, and the remaining one-third was converted to the bag system in the third year of the project.

The use of the bag makes the handling of household solid waste much easier for the homeowner and removes most of the objections of employees concerning the collection of solid wastes. Reaction of homeowners to the bag system has been favorable. A questionnaire survey made in January 1967 indicated that 94 percent of the people using the bag system liked the change from cans to bags and would not want to go back to the former method of collection.

Failure of the bags because of animal attack has been more frequent than anticipated. In some cases, it is believed that overfilling and improper closure have resulted in more attacks by dogs than would ordinarily have occurred. The bag has proved to be attractive to these animals after being placed at curbside. To reduce these failures, the town has initiated a local leash law and also recommended possible changes in the bag itself to provide extra strength and less attractiveness to dogs.

Comparative operating costs between the old and new collection systems are being evaluated. Preliminary estimates indicate that the bag collection system is more efficient and economical than other methods, but the savings are not enough to offset the complete cost of the bags. Indications are that the change to the bag collection system reduces the man-minute per ton collection time by approximately 50 percent. Since this increased efficiency is reflected by reduced labor and equipment costs, the town estimates that these economies offset approximately 11 cents per dwelling unit collected per week out of the 18 cents cost for supplying two bags to each dwelling unit per week.

Improvements are being made to the existing landfill to bring it into comformity with State and Federal recommendations. Preliminary indications are that the rate of use of the sanitary landfill has increased beyond that normally expected. The town attributes this increase to the availability and efficiency of the bag collection system.

Data are being continuously collected to further verify and substantiate the preliminary results to date. This data will be analyzed, and the findings presented in a final report after the project terminates.

PUBLICATION:

First community grant; municipal public works. *New England Construction*, Jan. 30, 1967.

Solid waste reduction/salvage plant

PROJECT TYPE: DEMONSTRATION **GRANT NO. D01–UI–00004**

GRANTEE: CITY OF MADISON, WISCONSIN

PROJECT DIRECTOR: JOHN J. REINHARDT, CIVIL ENGINEER III, ENGINEERING DEPARTMENT,
ROOM 115, CITY–COUNTY BUILDING, MADISON, WISCONSIN 53709

ESTIMATED TOTAL PROJECT COST:	**$532,445**
GRANTEE'S SHARE:	**$177,482**
FEDERAL SHARE:	**$250,000 [01]**
(BY YEAR OF PROJECT LIFE)	**$ 60,000 [02]**
	$ 44,963 [03]

DATE PROJECT STARTED: JUNE 1, 1966 **DATE PROJECT ENDS: MAY 31, 1969**

OBJECTIVES: To demonstrate possible improvements attainable in solid waste disposal practices by (1) making an economic study of the Gondard Process of milling solid wastes as a means of reducing volume for the purpose of extending the life of a landfill; (2) evaluating the sanitary aspects of milled solid wastes especially with respect to rodents, insects, odor, dust, blowing litter, and fires; (3) determining the feasibility and sanitary aspects of using milled domestic solid wastes as collected from households, without separation, for deposit in a fill site without cover; (4) evaluating the economic feasibility of salvaging items such as paper and metals; (5) investigating physical changes in the condition of milled solid wastes versus unmilled solid wastes in the fill site.

PROCEDURES: A Gondard hammer-type reduction mill will be constructed to process a portion of the solid wastes produced in the city of Madison. The first year's milling operation will be conducted in 12 separate periods, each of one month's duration, in accordance with the following schedule: first month, combined domestic refuse; second month, domestic garbage only; third month, domestic refuse other than garbage. This sequence will be repeated three more times to permit evaluation of seasonal effects on each of the three categories of solid wastes. Milled refuse produced during each period will be placed in a separate landfill cell. The surface of each cell will be leveled by a front-end loader, and each cell will be packed occasionally by a bulldozer.

For control purposes, sanitary landfill cells of unmilled solid wastes will be constructed. Each control cell will contain the same weight of material as is placed in the corresponding milled-refuse cell.

For one cell of each type of refuse, three different grate mesh-sizes will be used in the mill, in order that an economic analysis may be made to determine the optimum mesh-size.

The economic and technical feasibility of the milling process will be evaluated. Studies will be made to determine reduction of landfill volume requirements for milled wastes, and comparative characteristics of milled and unmilled wastes relative to settlement, leaching, gas production, and rodent, insect, odor, dust and blowing litter problems.

Following completion of the test cells, milled solid waste will be worked into the regular landfill operation of the city.

Landfill and milling operations will be conducted by employees of the city of Madison. The Civil Engineering Department of the University of Wisconsin will conduct the evaluation phase of the project, under the direction of Professor Gerard Rohlich.

PROGRESS TO DATE: The Gondard refuse mill was placed in operation on June 14, 1967, and shakedown operations were conducted during the next 3 months. Some equipment modifications were needed during this time. Major problems encountered with the mill itself were overheating of the motor and frequent stoppages caused by large loads during the initial start-up period. The motor overheating problem was solved by providing larger heaters for the motor. Slow response of the original automatic controls caused the frequent overloading of the mill. This was corrected by modifying the controls and also allowing for hand stopping of the feed belts. Experience has demonstrated that optimum production is obtained when the mill operator visually monitors the feed and bypasses the automatic controls.

On Sept. 18, 1967, milling of combined refuse for evaluating the project was begun. A summary of project operations from that date to Dec. 31, 1967, as reported by the grantee, is given below:

A 1-yr experimental program has been completed, and the reduction plant and landfill are now being operated in a conventional manner. During the experimental program, residential, combined refuse was milled each season through grates of different sizes. Some of the refuse was not milled; thus, comparisons can be made between milled and nonmilled refuse, in addition to comparing refuse milled through different sized grates. Currently, the plant is being operated by using one size of grate in the mill, and by constructing fewer, but larger, cells of refuse in the landfill. Thus the costs and characteristics of a production operation are being determined.

The production rate of the plant ranged from 6.8 to 7.7 tons per hr for the 3½- and 6¼-in. grates, respectively. The quantity of material that can be ballistically rejected out of the machine varies from 1 to 7 percent depending on the size of grate used in the mill.

The operating cost of the small-scale, pilot-plant operation was approximately $7.00 per ton when using the 5-in. grates. Based on experience gained with the pilot-plant operation, cost projections are made for a better designed, equipped, and operated plant.

Local scrap dealers indicated no interest in salvaging paper after it had been in a collection truck. Furthermore, the comment of the most interested salvage dealer was that there were too many tin cans in the rejected metals to pass for #2 grade scrap iron and that the rejects were too heterogeneous to extract tin from cans.

Preliminary analyses of the leachate from milled and nonmilled cells indicates that the dissolved oxygen in all leachates is virtually zero. Further analyses are being made for more refined evaluation of leachate quality. The nonmilled cells, which are covered with dirt, are producing less leachate than the milled cells, which are not covered.

Physical analyses indicate that the refuse contains approximately 15 percent food wastes and 40 percent paper products. The moisture content varied from 30 to 48 percent.

Plots of settlement versus time indicate that after 1 yr, the surface of the 6-ft deep cells have settled about 0.25 ft in the milled cells, and more than 0.50 ft for the nonmilled cells.

Based on observations to date, using milled refuse in a landfill results in a substantial increase in the quality of operation. Wind-carried litter and odors are less than for nonmilled refuse landfills. Additional benefits of using milled refuse include: (1) ease of spreading, which might reduce the amount of final cover dirt required to bring an area to grade, (2) ease of following a grading plan and providing drainage during the landfill construction, (3) building access roads to desired dumping areas, and (4) possibly not having to be as prompt in providing cover dirt, if any is required.

Cost of the existing plant (one mill operated one shift) is $6.60 per ton; projections for expansion of the existing plant (two mills operated two shifts) indicate that this cost can be substantially reduced. Four employees are required to operate the present plant, one of whom has been concerned with making modifications in the demonstration mill itself. It is estimated that if a second mill were added the same number of personnel could operate the enlarged plant.

PUBLICATION:

Solid waste reduction/salvage plant; interim report. City of Madison pilot plant demonstration project, June 14 to Dec. 31, 1967. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. 25 p.

Solid waste disposal study for Kalamazoo County, Michigan

PROJECT TYPE: STUDY AND INVESTIGATION GRANT NO. D01–UI–00005
GRANTEE: KALAMAZOO COUNTY ROAD COMMISSION
PROJECT DIRECTOR: E. L. BOCKSTANZ, ENGINEER MANAGER, KALAMAZOO COUNTY ROAD COMMISSION,
P.O. BOX 2127, KALAMAZOO, MICHIGAN 49005
ESTIMATED TOTAL PROJECT COST: $12,000
GRANTEE'S SHARE: $ 4,000
FEDERAL SHARE: $ 8,000 [01]
(BY YEAR OF PROJECT LIFE)
DATE PROJECT STARTED: JUNE 1, 1966 DATE PROJECT ENDED: MAY 31, 1967

OBJECTIVES: To demonstrate how new and improved solid waste management techniques could solve a regional solid waste problem by developing an area-wide solid waste management plan for Kalamazoo County.

PROCEDURES, FINDINGS, AND RECOMMENDATIONS: The consulting engineering firm of Jones, Henry & Williams, Toledo, Ohio, conducted the study. Local personnel provided assistance to the consultant's staff, and data accumulated by local agencies was made available.

Major findings concerning solid waste practices and problems were as follows:

Existing collection practice in Kalamazoo County makes each household and commercial or industrial unit responsible for its own solid waste disposal. Present rates by private haulers tend to restrict residential collection to one 20-gal can, which is picked up about seven times per month. Refuse not collected by the hauler is stored on the premises until a trip to the dump is convenient, or it is burned.

There are 14 public disposal sites serving 24 political subdivisions in the county. Many of these sites are poor examples of environmental health programs. Even those that try to operate in a satisfactory manner fall short of sanitary standards, apparently because of efforts to conserve land or lack of operating capital.

Most of the existing sites make no charge for dumping by township or village residents, and the cost of operation is paid from the general operating budget.

The collection methods in use in the county made it impossible to determine the total amount of solid waste actually produced. Available information was obtained by interview and questionnaire concerning commercial and industrial solid waste production, and estimates of total generation in the county developed. Data relative to the generation of residential solid wastes in other nearby areas were obtained and used to estimate both present and future quantities for Kalamazoo County. The estimated amounts, as used in this study, were:

Class of refuse	*Generation (Tons/day)* *1966*	 *1985*
Residential	200	700
Commercial	280	750
Industrial	1070	1930

The following recommendations for a countywide collection and disposal system were made by the consultant. (1) To protect the public health and welfare, all refuse collection and disposal should be placed under the authority of a single county agency. (2) A countywide collection system for both garbage and rubbish should be instituted; this would include weekly residential collections with the setout setback method of pickup. Cans and containers would be furnished by the county. The county should also collect commercial and industrial refuse, except for materials requiring special handling, or materials of large bulk; these should be collected by contract collectors. Such revisions in the existing system will reduce the cost of refuse service for all citizens of Kalamazoo County. (3) Sanitary landfill is the most economic method of refuse disposal available to Kalamazoo County at this time. A minimum of three sites for all solid waste disposal will be a practical solution for residential, commercial, and some industrial refuse. A separate site will be needed for such products as dried papermill sludges, construction and demolition debris, and tree wastes. (4) Special assessments should be levied against all properties producing solid waste; this is a simple method of collecting revenue and a way to avoid out-of-pocket payments. This source of funds can be supplemented by surcharges against commercial and industrial customers. (5) A planned program of public relations and public information should accompany any project undertaken by the county's refuse agency.

Hydrogeology of solid waste disposal sites

PROJECT TYPE: STUDY AND INVESTIGATION **GRANT NO.** D01–UI–00006
GRANTEE: UNIVERSITY OF ILLINOIS
PROJECT DIRECTORS: ROBERT N. FARVOLDEN, ASSOCIATE PROFESSOR OF GEOLOGY,
DEPARTMENT OF GEOLOGY, UNIVERSITY OF ILLINOIS, URBANA, ILLINOIS 61801
GEORGE M. HUGHES, ASSISTANT GEOLOGIST, ILLINOIS STATE GEOLOGICAL SURVEY,
115 SOUTH WASHINGTON STREET, NAPERVILLE, ILLINOIS 60540

ESTIMATED TOTAL PROJECT COST:	$98,632
GRANTEE'S SHARE:	$46,032
FEDERAL SHARE:	$47,031 [01]
(BY YEAR OF PROJECT LIFE)	$ 5,569 [02]

DATE PROJECT STARTED: JUNE 1, 1966 **DATE PROJECT ENDS:** MAY 31, 1969

OBJECTIVES: To investigate hydrogeologic environments currently being used as sanitary landfills for solid waste disposal and to evaluate the factors controlling groundwater and landfill leachate movement in these environments.

PROCEDURES: The study is being conducted by staff members of the State Geological Survey and the Department of Geology, University of Illinois.

Several landfill sites in northeastern Illinois, representing some five different hydrogeologic environments, will be selected for study. A detailed boring program will be developed for each site, and investigations will proceed as follows:

Holes will be drilled by wash boring or with hollow-stem augers, and samples selected to describe the character and sequence of geologic deposits. Piezometers will be installed in the holes to define fluid potential distribution, and, thereby, the groundwater flow system. Water samples for chemical analysis will be collected from the piezometers whenever possible, and from additional borings that might be necessary for a definition of water quality. A program to monitor piezometer water levels will be continued for at least 1 yr to define the seasonal variations in the groundwater flow system.

PROGRESS TO DATE: Four sites were selected for study: one in DuPage County, one near Elgin, one near Woodstock, and one near Winnetka. Hydrologic investigations were conducted substantially in accordance with the planned procedures. The field work at all sites has been substantially completed; however, groundwater elevations are being monitored until the project terminates, to determine seasonal variations of flow. Conclusions and recommendations developed to date by the project staff appear below:

CONCLUSIONS: At each of the sites studied, groundwater flow patterns are relatively simple; and the hydrogeologic factors responsible for the patterns can, in most cases, be readily understood. The distribution of dissolved solids in the groundwater are, with very few exceptions, in accord with the flow system determinations: the dissolved solids from the various landfills move in a predictable manner. The approach used in this investigation should, therefore, be applicable for determining the suitability of proposed disposal sites.

The four sites studied were not selected because of their suitability or unsuitability for refuse disposal. It appears, however, that although these sites are discharging dissolved solids, three of them are not adversely affecting a water resource.

At each of the sites, precipitation has moved downward through the fill surface and the refuse to produce a leachate with a high content of dissolved solids that has migrated out of the filled area. At the DuPage County, Winnetka, and Woodstock sites, these dissolved solids have migrated for relatively short distances through a surficial sand and have been attenuated to a considerable degree during this migration. This surficial sand is not and probably will not be used for water supplies. At the Elgin site, these dissolved solids have affected a shallow well between the landfill and the Fox River.

Springs and seeps of landfill leachate are present in the vicinity of all four sites. At the Elgin and Woodstock landfills, these are small and do not appear to be a health hazard. At the DuPage County and Winnetka landfills, these springs are larger and present a local sanitary nuisance.

There is movement of groundwater from the landfills at DuPage County and Woodstock into small nearby streams. Limited chemical analyses have not detected leachate in these streams, but there is reason to believe it could be present in detectable quantities.

No evidence has been found that dissolved solids have moved downward through the clay tills underlying any of the sites studied. It is not yet known whether this is because not enough time has elapsed for the water to have migrated downward to the first available sampling point, or whether the dissolved solids have been adsorbed or their migration blocked by the clay materials.

The cation exchange* capacity of the tills beneath the DuPage County, Elgin, and Winnetka sites is between 4 and 6.2 milliequivalents per 100 grams, with the major exchangeable cation being calcium. As all exchange positions are probably filled and calcium is a difficult cation to replace, adsorption of cations by these clays is likely to be low; if it takes place, it would result in an increase in groundwater hardness. The effect of these tills on the migration of refuse leachate is not understood; however, further studies are under way.

At each site, mineralization of groundwater in the fill declines with increasing age of the fill. However, the amount of mineralization associated with fill of a given age cannot be correlated from area to area. There is less evidence that the inverse relation between age of fill and amount of mineralization holds for points immediately adjacent to the fill.

The results of the water quality analyses are not directly comparable, and only general conclusions as to the distribution and migration of leachate in the shallow deposits can be drawn from them. High organic acids and chemical oxygen demand are found in relatively young refuse; and these components do not appear to travel far from the landfill area, except at the Elgin site. Hardness is very high in samples from within the landfill, but decreases rapidly with distance away from the landfill, though not as rapidly as the organic components do.

Chlorides were perhaps the best indicator of leachate migration as they decreased rather regularly from hundreds or thousands of parts per million within the landfills to tens of parts per million away from the landfills. They also traveled farther than the other dissolved solids. Total dissolved solids acted in much the same manner as the chlorides. The concentration of sulfates, manganese, and iron declined with increased distance from the landfill, but more erratically than the concentration of chlorides and total dissolved solids.

Bromine was the only "unusual" element found in the landfill leachate. Values for bromine reached 15 ppm, but decreased rapidly away from the landfill. The source of the bromine is probably vegetable matter; however, this has not been confirmed.

Analysis was run for selenium, but it was not present in appreciable quantities.

In northeastern Illinois, precipitation is adequate to infiltrate a landfill and to produce a leachate high in dissolved solids. Various covering and grading methods could probably be used to reduce the amount of infiltration; however, eliminating it completely would be impractical. Infiltration of precipitation is encouraged by a flat fill surface with a cover of permeable material supporting grass and weeds. This situation is not uncommon in northeastern Illinois landfills, and, in fact, landfills are commonly graded level and seeded.

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* Cation exchange is the ability of a clay mineral to absorb cations and exchange them for other cations introduced into the clay-water system.

In groundwater recharge areas, water, after moving through the filled area, will move downward unless intercepted by a surface stream or tile, or a natural discharge area. More permeable deposits, interbedded with or overlying tills that have low permeability, will disperse leachate moving from a landfill over a wider area, but will not eliminate the downward movement.

RECOMMENDATIONS: Under conditions existing in northeastern Illinois, there appears to be no practical method of landfill construction that would completely eliminate the movement of dissolved solids from a disposal site. If this assumption is accepted, the problem of selecting suitable sites becomes that of choosing hydrogeologic environments that can accept or eliminate dissolved solids without ill effect. Although there are areas in northeastern Illinois where solid waste disposal would be harmful to the groundwater resource, these appear to be relatively rare compared to the number of favorable areas.

Many prospective sites are in abandoned gravel pits and quarries. These sites have a major disadvantage in that they are in relatively permeable materials that allow rapid movement of leachate. If the quarry is in fractured rocks, such as the limestones and dolomites of northeastern Illinois, very little attenuation or purification of the leachate will occur during travel. Such sites could be used, however, under the following conditions: (1) If groundwater movement at the site is upward and there is no possibility of a reversal of this direction by pumping or other forms of development before the landfill has become inert. (2) If impermeable materials beneath the fill will inhibit the downward movement of leachate until it has migrated laterally to a discharge area that is capable of assimilating it without ill effect. Such conditions occur naturally or could be developed by collection and treatment of the leachate at the disposal site. (3) If (although movement is downward through permeable materials) there is no aquifer or groundwater resource along the travel path of the leachate for a distance sufficient to permit natural processes to purify the leachate to an acceptable level. (The existence of the above conditions would be very difficult to prove, particularly in fractured rocks.)

Pit or quarry sites have some advantages for landfill use. The land is generally inexpensive, and its value may be increased by filling. In addition, stabilization of the fills should be rapid because leaching would be promoted by the conditions at such sites.

Sites in some parts of northeastern Illinois should be regarded with caution. They are in recharge zones, in permeable materials, and are often upgradient from areas where large amounts of groundwater are being used. These critical areas are: (1) The upland gravels east and west of the Fox River Valley. (2) Those parts of the upland areas in eastern and southern DuPage County, southern Cook County, and northern Will County where bedrock is exposed or close to the surface. (3) Lowland areas along the Fox and Des Plaines Rivers where permeable materials overlie the aquifers and recharge conditions may have developed because of heavy pumpage. (It should be pointed out that heavy pumpage may have a beneficial effect in that it may dilute leachate to tolerable levels and removes it from the groundwater reservoir.)

Abandoned or worked-out coal strip mines southwest of the metropolitan area show some promise as disposal sites, but they have not been investigated in this study. Land values are relatively low in these areas, and an excavation and cover materials are generally available. Strip mines are often associated with materials of low permeability and are usually isolated from areas of high groundwater use. In addition, rail facilities are often present for large-volume transport.

It was not possible to study a disposal site located entirely in clay with no associated sand or silt material. The following would be expected to apply to such sites: (1) The ground-water mound beneath the fill would be higher than in other sites because there would be a greater contrast between the permeabilities of the refuse and the surrounding clay. (2) Springs from the side of the fill could be a problem. (3) Leachate collection facilities could be easily constructed.

Stabilization time should also be considered in selecting sites, particularly if treatment facilities are planned or if future use of the site is contemplated. Stabilization time should be decreased if leaching is rapid. Permeable cover materials and rapid drainage will increase the speed of leaching, but will also increase both the daily and the total amount of leachate moving from the fill.

In some limited areas in northeastern Illinois, thick surficial gravels are present, and refuse could be deposited above the top of the zone of saturation. Unless the tops of these sites are sealed, leachate would be produced by infiltrating precipitation. The quantity and rate of leachate production would probably be low in this type of environment because the landfill would not be continuously saturated. Gas production and its migration through the permeable gravels, however, could present problems.

The major advantage of reducing infiltration into a landfill would be the reduction of the total quantity and rate of leachate production and the diminishing of the rate of growth of a groundwater mound. There are also disadvantages. Reduction of infiltration would probably extend the "polluting" life of the landfill. If cover material with low permeability is used, it would tend to force more of the gas produced to move laterally, rather than upward through the landfill surface. In addition it would entail more expense.

Measures to reduce infiltration might best be considered when it is necessary to collect and treat the leachate or when the natural environment is not capable of handling the amount of leachate produced.

To save space and to provide hill slopes for recreational activities, refuse in some landfills in northeastern Illinois is being piled 50 to 100 ft above the original land surface. Infiltration into this type of fill should be minimal because surface drainage is usually well planned and a thick cover is generally used. However, as in natural hills, a ground-water mound will form unless infiltration can be completely eliminated, and a leachate will eventually be produced. Leachate springs could be a problem in such landfills, as could slumping of the landfill sides.

PUBLICATIONS:

LANDON, R. A. Application of hydrogeology to the selection of refuse disposal sites. Second Mid-Atlantic Industrial Waste Conference, Drexel Institute of Technology, Philadelphia, Pennsylvania, Nov. 18-20, 1968.

HUGHES, G. M., R. A. LANDON, and R. N. FARVOLDEN. Hydrogeology of solid waste disposal sites in northeastern Illinois; an interim report on a solid waste demonstration grant project. [Cincinnati], U.S. Department of Health, Education, and Welfare, 1969. 137 p.

Solid waste study and planning grant-Jefferson County, Kentucky; Floyd and Clark Counties, Indiana

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PROJECT TYPE: STUDY AND INVESTIGATION **GRANT NO.** D01-UI-00007
GRANTEE: UNIVERSITY OF LOUISVILLE, INSTITUTE OF INDUSTRIAL RESEARCH
PROJECT DIRECTOR: JOHN E. HEER, JR., PROFESSOR OF CIVIL ENGINEERING,
UNIVERSITY OF LOUISVILLE, LOUISVILLE, KENTUCKY 40208

ESTIMATED TOTAL PROJECT COST:	$175,820
GRANTEE'S SHARE:	$ 57,900
FEDERAL SHARE:	$ 45,960 [01]
(BY YEAR OF PROJECT LIFE)	$ 71,960 [02]

DATE PROJECT STARTED: JUNE 1, 1966 **DATE PROJECT ENDS:** MAY 31, 1969

OBJECTIVES: To demonstrate how new or improved solid waste management techniques could solve a regional solid waste problem by developing a regional plan for solid waste disposal for the Louisville metropolitan area, which consists of Jefferson County, Kentucky, and Floyd and Clark Counties, Indiana.

PROCEDURES: The project is being conducted by staff of the University of Louisville Institute of Industrial Research, Departments of Civil and Chemical Engineering..

Sources and quantities of solid wastes generated in the study area will be determined. Methods of solid waste disposal most suited to the area and the types of waste generated will be investigated. A computer program employing systems analysis techniques and the linear programming method will be developed to optimize the disposal system on a regional basis.

PROGRESS TO DATE: The following material has been extracted from a draft of the grantee's final report for Jefferson County, Kentucky:

Solid wastes considered included domestic garbage and trash, commercial and industrial nonliquid refuse, incinerator ash, junk, discarded automobiles, sewage sludge, municipal and institutional rubbish, and demolition and construction wastes.

Estimates of present and future refuse quantities were developed from population and industrial growth projections made by Hammer and Company Associates, and Arthur D. Little Company, past records of municipal and private refuse haulers, incinerator records, domestic and commercial sampling studies, questionnaires, personal interviews with representatives of local industry and business, and observations of refuse entering major disposal sites in the county.

Unit values were developed expressing refuse quantities in terms of pounds per capita per day or pounds per employee per day and these were applied to demographic information supplied by the Jefferson County Planning Commission to determine the distribution of refuse sources within the county.

All major disposal sites operating in the county were visited and surveyed. Where weight or volume records were not available, estimates were made of the daily loading of each facility. The maximum capacity and life expectancy of each disposal site were estimated. Current operating costs were determined for the Louisville incinerator, and cost estimates were made for the privately owned landfills.

Disposal methods currently available were carefully studied and compared on the basis of economic and aesthetic suitability. Solid wastes disposal techniques in the research or early development stages were also investigated and evaluated as to future feasibility. Costs comparisons of new disposal methods with current methods were made whenever possible.

Selections of potential transfer facilities and disposal sites were coordinated with county planning and health agencies to ensure compatibility with other community planning goals. In some cases, more than one type disposal facility was investigated for a particular site.

Present methods of transporting solid wastes were studied and hauling costs estimated. New modes of refuse transportation, such as pipeline or rail transfer, were evaluated for possible use in the future. In accordance with stated project objectives, collection methods and techniques were considered outside the scope of this study.

A linear programming model was developed to determine the locations and types of disposal facilities that would result in the most economical disposal system for Jefferson County. Although the optimum system was based on minimum cost, other considerations, such as aesthetics, were included in selecting the model constraints. The primary function of the model was to evaluate competitive systems and aid in development of general, long-range plans, rather than simulate the existing disposal system.

A short-time plan was developed to provide Jefferson County relief from its immediate and serious solid waste disposal problems. In addition, however, long-range programs were developed, based on current and experimental disposal methods, to provide for solid wastes disposal until 1990. The program considers the types and quantities of wastes expected to be produced within Jefferson County and a mechanism is provided to permit evaluation of future disposal techniques for possible inclusion in the county disposal system.

FINDINGS AND RECOMMENDATIONS: *Current conditions. 1. Collection.* Municipal collection of residential wastes is provided by the cities of Louisville, Shively, and Audubon Park. All other incorporated and unincorporated areas of Jefferson County rely on private haulers for collection of residential refuse.

Although Louisville offers limited collection service for commerical and industrial firms located within city limits, most refuse of this type is collected by private haulers.

2. Disposal. All domestic refuse from the city of Louisville is incinerated at the Meriwether incinerator. This incinerator plant also handles large quantities of commercial and industrial wastes from private refuse collectors. The Meriwether plant contains four 250-ton rotary-kiln furnaces, frequently loaded beyond its design capacity of 1,000 tons per day. Domestic refuse from areas of Jefferson County other than Louisville is taken to either of two privately owned and operated landfills; one in the western portion of the county at the foot of Lee's Lane, and one (in the east, on Ash Avenue) on the Jefferson-Oldham County line. The city of Louisville also operates a landfill on the northern edge of the county between River Road and Interstate-71. This site is restricted to incinerator residue, junk, and waste from the Parks Department and the Metropolitan Sewer District.

The increasing quantities of solid wastes, together with the fact that Jefferson County haulers have been barred from using disposal sites in neighboring counties, have placed a heavy load on existing disposal facilities.

The existing incinerator may require additional air pollution controls in the near future to comply with more stringent codes. Existing landfills are uneconomically located for many areas of this county and will probably be exhausted within 5 years. Present landfill operators will be forced to improve their operations to meet new State standards for sanitary landfills. Although the effect of these new standards on existing landfill practices in Jefferson County is not known, operating costs will undoubtedly be increased.

Refuse quantities and projections. Approximately 2,800 tons of refuse are being generated daily in Jefferson County; about half of this is incinerable. The total quantity of refuse is expected to increase to approximately 4,800 tons per day by 1995.

1. Domestic Refuse. Residential households produce about 2 lb of refuse per capita per day. Approximately 700 tons of refuse from this source is generated daily in Jefferson County. The two major components of refuse are paper and paper products comprising about 59.7 percent of the total by weight and putrecible foodstuffs, or garbage, comprising about 19.7 percent of the total by weight.

2. Commercial Refuse. Between 250 and 300 tons of this type refuse is produced daily in Jefferson County. Commerical refuse quantities vary widely with the type and size of enterprise, but on the average, commercial businesses produce about 4.6 lb of refuse per employee. The composition of the combined commercial refuse output in Jefferson County is very similar to that of residential refuse, with paper and garbage the predominate components.

3. Industrial Refuse. Approximately 1,400 tons of refuse is produced daily by Jefferson County industries. Of this total quantity, about 21 percent is salvaged, 52 percent is collected by private and municipal haulers and enters the community disposal system, and 27 percent is disposed of by industry on its own property. Industrial refuse is so diversified it is impractical to make generalizations regarding its composition.

4. Municipal Refuse. About 250 tons of refuse is generated each day from activities related to normal municipal activities. The primary contributors are: schools, 36 tons per day; junk pickups, 35 tons per day; street sweepings, 30 tons per day; and the sewage treatment plant sludge, 150 tons per day.

5. Demolition and Construction Refuse. These activities produce about 250 tons of refuse daily in Jefferson County. Although some of these wastes are taken to the major landfills, a large portion is used to fill small holes on private property.

Alternate disposal methods. 1. Landfill. Sanitary landfill is recommended as the primary disposal method for Jefferson County for the next 15 to 20 yr. Sanitary landfill is the most economical disposal method currently available. Properly operated, a landfill disposal site need not be objectionable from either a health or aesthetic standpoint. In addition to being a low cost disposal method, landfill can also be used to reclaim marginal land. The widely used practices of open dumping and burning have made any type of landfill operations distasteful to many people, and it may be difficult to sell the public on the use of sanitary landfill in spite of its economy.

2. Incineration. Modern incineration is widely used as a refuse disposal method. Incineration does not eliminate the need for landfilling. Depending on incinerator design and refuse characteristics, incinerator residue quantities can range from 15 to 30 percent of input by volume. This residue is much cleaner and more compact than raw refuse and is a superior fill material.

When compared with disposal, incineration is expensive; it costs an estimated four to six times as much in the Jefferson County area. Incinerators are economical when land values are high and landfill sites are located long distances from refuse sources. Most existing incinerators, including Louisville's, are plagued by air pollution problems. New, more stringent, air pollution codes being adopted by most metropolitan areas will also substantially increase the cost of new incinerators.

3. Composting. This disposal method is not recommended for this area in the foreseeable future.

4. Rail Haul. The obvious advantage of transporting refuse by rail to distant strip mines is that the wastes are removed from the area entirely, and this is often desirable from an aesthetic standpoint. At present, however, techniques for rail transfer of refuse are still in the developmental stage. In the few instances of actual contracts for refuse disposal by this method, the costs have been about four times the cost of landfill in this area.

Work is proceeding on the development of similar information in Floyd and Clark Counties, Indiana.

High-density landfill recovery program

PROJECT TYPE: DEMONSTRATION **GRANT NO. D01–UI–00009**

GRANTEE: KING COUNTY SANITARY OPERATIONS

PROJECT DIRECTOR: JOHN NICHOLSON, ASSISTANT DIRECTOR, KING COUNTY SANITARY OPERATIONS,
608 KING COUNTY COURTHOUSE, SEATTLE, WASHINGTON 98104

ESTIMATED TOTAL PROJECT COST:	**$599,159**
GRANTEE'S SHARE:	**$199,720**
FEDERAL SHARE:	**$250,000 [01]**
(BY YEAR OF PROJECT LIFE)	**$149,439 [02]**

DATE PROJECT STARTED: JUNE 1, 1966 **DATE PROJECT ENDS: MAY 31, 1969**

OBJECTIVES: To demonstrate a new and improved method of solid waste disposal by constructing and operating a machine that will compact refuse at 200 psi, extrude the compacted refuse substantially below ground level, and compact cover material placed over the in-place refuse by auxiliary earthmoving equipment.

PROCEDURES: A prototype compacting machine, capable of handling about 2,000 tons of solid wastes per day, will be constructed and operated at King County's Cedar Hill landfill site. Operating costs and characteristics of the compacting machine, and settlement and bearing characteristics of the fill, will be determined. Gas production in the fill will be investigated.

The firm of Johnston, Campanella, Murakami and Company, Renton, Washington, will provide design, evaluation, and other necessary consulting engineering services.

A film, documenting the project from initial conception through final evaluation, will be produced.

PROGRESS TO DATE: Bids for construction of the compacting machine (otherwise known as "the mole") were awarded on Sept. 18, 1967. The machine was essentially completed and moved onto the demonstration site in mid-1968 and was successfully tested in July of that year. The county's transfer trailers have been modified to permit easy dumping of solid wastes into the compacting machine. The trailers have been converted from the conventional end-unloading type to a type having two 42-cu-yd containers on the truck bed. These containers are filled with solid wastes at the transfer station and, one at a time, a hydraulic unloader turns the container upside down and empties it into the hopper of the mole at the site. The unloading operation takes about 3 to 4 min for each container. A large hydraulic cylinder in the mole then compresses and extrudes the refuse into a trench previously excavated by auxiliary equipment.

Special earth tamping devices provided on the mole to compact the backfilled earth have been found to be unnecessary; a bulldozer adequately compacts the backfill. Other preliminary observations are: 1. Refuse is extruded from the mole as a 7- by 7-ft strip, which does not expand appreciably as it leaves the machine, and is deposited in the trench. 2. In-place density of the extruded material is estimated to be 1,500 to 2,000 lb per cu yd. 3. As a preliminary test, a 1-day production of refuse from King County (800-900 tons) was compacted and buried by the equipment in about 8 hr in October 1968.

Rainy weather has hampered evaluation operations and delayed completion of the project. Data on density, land use, time of operations, and costs are being developed.

Waste incineration in mechanically agitated fluidized beds

PROJECT TYPE: STUDY AND INVESTIGATION **GRANT NO.** D01–UI–00010
GRANTEE: BOARD OF GOVERNORS, WEST VIRGINIA UNIVERSITY
PROJECT DIRECTOR: RICHARD C. BAILIE, ASSOCIATE PROFESSOR, DEPARTMENT OF CHEMICAL ENGINEERING, WEST VIRGINIA UNIVERSITY, MORGANTOWN, WEST VIRGINIA 26506
ESTIMATED TOTAL PROJECT COST: $195,729
GRANTEE'S SHARE: $ 65,243
FEDERAL SHARE: $ 59,103 [01]
(BY YEAR OF PROJECT LIFE) $ 71,383 [02]
DATE PROJECT STARTED: JUNE 1, 1966 **DATE PROJECT ENDS:** MAY 31, 1969

OBJECTIVE: To demonstrate, by a quantitive study, the potential advantages of utilizing the fluidized bed as an incineration method of solid waste disposal.

PROCEDURES: The project is being conducted by staff of the Department of Chemical Engineering, the Department of Civil Engineering, and the Engineering Experiment Station, West Virginia University, and will be carried out in three phases as follows:

Phase I. A fluidized bed pilot plant will be designed and constructed. Operating characteristics will be determined, and the effects of a number of factors on bed operation will be evaluated. Garbage mixed with rubbish will be treated. An economic analysis of fluidized bed burning of refuse and rubbish as a source of energy for a steam generating plant will be developed.

Phase II. Based upon information and experience gained in Phase I, the equipment will be modified or overhauled for the incineration of sewage sludges. The experimental investigation will follow the pattern of phase 1.

Phase III. Based upon the results obtained in Phases I and II, optimization studies will be carried out on the disposal of wastes in fluidizing beds. Consideration will be given to plants for the incineration of garbage and rubbish, sewage sludges, and combination plants for cities of various sizes.

A final report will be prepared describing the advantages and disadvantages of a fluidized bed incinerator, as demonstrated on a pilot plant scale, for several types of solid wastes. The optimum system for several case studies, including heat recovery, sewage sludge disposal, etc., will be given. The system will take into account both cost and necessity of a more clean effluent. Fluidized bed incineration will be compared with other methods of disposal.

PROGRESS TO DATE: A second generation pilot plant has been constructed. The results from the first unit have shown:

1. Burner design for bed heat-up is adequate.
2. Isothermal operation can be achieved with and without auxiliary heat source.
3. Heat transfer rates to horizontal cooling tubes found is 50 to 200 Btu per hr per degree F per sq ft.
4. Granular material such as anthracite coal and sand may be fed by a screw feeder.
5. Sewage sludge may be fed from a piston feeder with tapered end.
6. Control of bed is simple.
7. Heat release rate of 150,000 Btu per hr per cu ft can be achieved.
8. Cooling is required for high heat release rates.
9. Sand elutriation rates are excessive.
10. Negligible odor and clean stack resulted from burning of rubber sewage sludge mixture in bed.

11. Pulse testing to obtain kinetics of combustion are valuable.
12. The volumetric generation rate was limited by heat removal rate.
13. Increased bed heights should be investigated.
14. Pulse testing appeared to yield the most valuable technique to obtain basic information on combustion in a reasonable period of time.

The second unit was constructed to allow for a wider range of operating conditions including:

1. Effect of specific materials in refuse on characteristics of bed. These include glass, cans, plastics, and rubber.
2. Heat release data to point of oxygen deletion.
3. More complete analysis of gas effluent and solid carryover.
4. Effect of bed height on combustion.
5. Pulse testing.

The modifications of the pilot plant included:

1. Increase of height to 12 ft.
2. Expanded section on top to minimize carryover.
3. Installation of blast ports for pulse feeding.
4. Installation of a heat removal coil that can be positioned to give variable area and thereby vary heat removal rate.
5. Installation of removable preheat burner.
6. Installation of new auxiliary heat source, adding fuel to fluidizing air.
7. Addition of continuous O_2 analysis.
8. More complete gas sample train.

The following significant results have been obtained:

1. For burning 1- by 1- by 12-in. pine block and charcoal briquets:
    (a) Reaction is not chemical reaction controlled.
    (b) Ninety percent of briquets burn in 3 to 4 min at 1700 F.
    (c) Little increase in burning rate is observed above 1700 F.
    (d) Ignition temperature is about 700 F for pine blocks and 900 F for charcoal.
2. Tin cans are oxidized and give off their reaction energy in the bed. About 10 min residence time is required.
3. Sand elutriation remained high.
4. Oxygen concentrations as low as 2 percent were obtained by inserting the heat removal coil in the bed.
5. In preliminary experiments, glass inserted in bed did not agglomerate.
6. The oxygen level had a significant effect on reaction rate.

The major problem for small-scale investigations continues to be the feeder. No satisfactory solution has been found for a reliable feed system that allows for continuous steady-state operations employing a wide variety of heterogeneous feed.

The pulse technique developed and presently being modified has proved to be a most valuable technique for the study of combustion efficiency and the effects of particle size, moisture content, bed temperature, oxygen concentration, heating value, etc. This technique is far less time consuming than a steady-state operation and gives valuable information about the kinetics of the combustion that could not be obtained from steady-state operation. This technique is being used to exclude areas of operation that would be undesirable to direct the time consuming steady-state operations toward the most significant areas for investigations.

The incineration of pine blocks and charcoal briquets in less than 5 min is a qualitative verification of high combustion rates. To take advantage of high combustion rates leading to small compact units, it will be necessary to remove heat even where there is no utilization of this energy.

The advantages in reducing gaseous emissions from incineration have not been substantiated. It would appear from other work, that the oxides of nitrogen may be more than predicted. On the other hand, pollutants such as sulfur dioxide, chlorine, etc., can be reduced substantially by adding material such as dolomite to the bed to tie up these trace constituents.

Gully reclamation method - landfill demonstration

PROJECT TYPE: DEMONSTRATION **GRANT NO.** D01–UI–00011
GRANTEE: SARPY COUNTY BOARD OF COMMISSIONERS, SARPY COUNTY COURTHOUSE,
PAPILLION, NEBRASKA 68046
PROJECT DIRECTOR: JOHN W. NEUBERGER, GENERAL MANAGER, PAPIO WATERSHED BOARD,
4538 SOUTH 84th STREET, OMAHA, NEBRASKA 68127

ESTIMATED TOTAL PROJECT COST:	$118,557
GRANTEE'S SHARE:	$ 39,519
FEDERAL SHARE:	$ 48,000 [01]
(BY YEAR OF PROJECT LIFE)	$ 21,300 [02]
	$ 9,738 [03]

DATE PROJECT STARTED: JUNE 1, 1966 **DATE PROJECT ENDED:** SEPT. 30, 1968

OBJECTIVES: To demonstrate an improved method of solid waste disposal that would provide erosion control and land reclamation in gullied areas by sanitary landfill operations and to promote acceptance of landfills for solid waste disposal.

PROGRESS TO DATE: The project was conducted by the staff of the Papio Watershed Board. The firm of Gollehon & Schemmer, Inc., Omaha, Nebraska, provided consulting engineering services in connection with the necessary construction to prepare the landfill site for use. The following summary has been abstracted from information provided by the grantee:

An eroded gully on farmland approximately 10 miles south of Omaha was selected to serve as the demonstration site. The gully was cleared of all trees and brush, and an earth dam was constructed at its mouth to establish a stable grade for the landfill and to prevent seepage from moving downstream. An all-weather access road was built to the site, the site area was fenced, and scales and an administration hut were provided. Volume of the gully as prepared for landfill use was estimated as being 32,080 cu yd. The primary service area was the Offutt Air Base–Capehart housing with an estimated population of 8,000. Because of its close proximity and easy access to a much larger service population, however, private citizens and industry from the nearby communities of Papillion (4,500), LaVista (3,500), Bellevue (22,000), Ralston (3,600), and several newly developed subdivisions also utilized the site for convenient disposal of solid waste.

From April 1967 to September 1968, the landfill was open for refuse disposal 6 days per wk, Monday through Saturday. A TD–18 International Crawler Tractor with bulldozer was operated each day of the week for compaction and daily cover. A free public disposal station, located outside the landfill gate, was opened to the public 24 hr each day and 7 days per wk. Refuse from private cars, station wagons, and small trailers was deposited into containers that were then hauled to the landfill face for disposal on a routine basis.

A full-time landfill operator was employed to provide constant supervision over the operation of the sanitary landfill. An office was established in the scale house and the equipment operator was trained to keep records on the incoming refuse. The operator was also responsible for collecting fees from the haulers or recording fees to be added to statements for monthly billing. The amount of refuse received each day was low enough for this site so that the operator also served as the equipment operator for cover and compacting the landfill. The average daily volume was 85 cu yd, or about 25 tons per day; however, on peak days, the amount would frequently triple, requiring one additional person to collect data and fees. Occasional additional labor was also used to haul cover dirt, pick up papers, mow weeds, or seed grass cover on the disturbed areas. The Sarpy County Building Inspector made periodic inspections of the operation.

Because of the physical configuration of the gully, variations of all three basic landfill methods (area method, trench method, and ramp method) were required when operating in this type of site. Consequently, more operator skill and judgment was required than for sites that can be filled by use of only one method.

Because of the prevalence of Dutch elm disease in the area, one of the major problems encountered arose in connection with the large quantities of trees received. This created operating problems and substantially increased the cost of operating the landfill. To solve this problem, a second nearby gully was used as a site for tree disposal. This was operated on a weekly spread and cover schedule.

During the life of the project, tours of the site by various interested groups were held, and county officials were briefed on progress from time to time at the site. The grantee indicates that this demonstration project is considered to have achieved its purposes since the county officials have accepted the sanitary landfill–land reclamation concept and have appropriated monies to continue these operations without further Federal assistance.

Some additional benefits quoted by the grantee are as follows:

Increase in farmable acreage. The demonstration gully occupied 4.5 acres of unfarmable land area. After completion of the fill, the entire area was seeded to brome grass for erosion control. It is planned to plant 4.5 acres of corn on the fill during the 1970 growing season. This is expected to increase the landowner's net income by some $225 per yr. An additional benefit is involved in that more efficient field travel is now possible.

Erosion control. It is estimated that this project has prevented 2 acres of land voiding by erosion that would have occurred during the next 25 yr. Estimated average annual benefit to property is $25 per acre per yr.

Stable outlet for terraced cropland. Construction of the grade control structure and filling the voided gully raised the waterway flow line an average of 20 ft. This provides a stable outlet for the terraces and grassed waterway applied to the 40 acres of cropland above the dam. The effect of this improvement is to triple the life of the terraces and waterways that are designed to hold in place an estimated 600 tons of soil that would have eroded off the land each year. Conservation practices applied are expected to reduce sediment yield from 20 to 5 tons per acre per yr. A frequently used value to estimate the benefits of reducing sediment from clogging waterways and reservoirs is $1 per ton. With that somewhat arbitrary value, the benefits to the property owner and the public for sediment reduction should exceed $600 per yr.

Land valuation increased. When useless land is reclaimed, the overall property value is improved, and more useable acres are added. The 4.5 acres reclaimed in this site will be used for crops, and it is estimated their valuation should increase from about $5 to $505 per acre within 5 yr. The extent of settlement, maintenance required, and productivity of the reclaimed acreage will establish a more reliable estimate of the improved land value. Based on the current property tax levy, the county could eventually realize at least a $30 increase in tax receipts for public services.

Multipurpose incinerator

PROJECT TYPE: DEMONSTRATION **GRANT NO.** D01–UI–00013

GRANTEE: CITY OF STAMFORD, CONNECTICUT, 429 ATLANTIC STREET, STAMFORD, CONNECTICUT 06901

PROJECT DIRECTOR: NORMAN W. WAGNER, SUPERVISOR OF SANITATION, BUREAU OF SANITATION,
MAGEE AVENUE, STAMFORD, CONNECTICUT 06901

ESTIMATED TOTAL PROJECT COST:	$1,092,749
GRANTEE'S SHARE:	$ 364,250
FEDERAL SHARE:	$ 250,000 [01]
(BY YEAR OF PROJECT LIFE)	$ 478,499 [02]

DATE PROJECT STARTED: JUNE 1, 1966 **DATE PROJECT ENDS:** MAY 31, 1969

OBJECTIVES: To demonstrate an improved solid waste disposal method by a project that will determine the feasibility of incinerating, in a multipurpose incinerator, solid wastes that normally are too bulky or volatile for charging to a conventional incinerator; and to demonstrate the practicability of using an electrostatic precipitator to meet State and Federal air pollution criteria.

PROCEDURES: The proposed incinerator will be designed and constructed by the city, which will also develop operational procedures for the facility and evaluate its performance with the assistance and advice of Elmer Kaiser, Advisory Consultant for the project. Elements of the evaluation phase of the project will include: (1) accurate measurements of weights and volumes of all wastes handled; (2) development of rules and regulations governing the delivery of wastes to the incinerator; (3) development of methods of controlled burning, determination of the compatability of varying types of wastes for joint burning, methods of charging the chamber, operating temperatures, draft measurements, and effectiveness of the electrostatic precipitators.

PROGRESS TO DATE: The consulting engineering firm of James P. Purcell Associates, Hartford, Connecticut, was retained to prepare the plans and specifications for the incinerator, provide assistance in the securing of bids, letting of the contract, and supervision of construction. Bids were opened in October 1967, and were substantially higher than the estimates. This resulted in a delay of several months, while arrangements were made to secure the necessary additional funds to proceed with the project. Sufficient funds were obtained, and construction of the facility is well underway. If construction continues at its present rate, the unit should be ready for a shakedown run in April 1969.

The first phase of a citywide industrial waste survey to determine what wastes will require special handling has been completed. The second and final phase of this survey, consisting of the collection of samples of industrial wastes that will require special handling, will begin in the near future.

Land reclamation by accelerated stabilization and related studies of compactor equipment

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PROJECT TYPE: DEMONSTRATION **GRANT NO.** D01–UI–00018

GRANTEE: CITY OF SANTA CLARA, 1500 WARBURTON AVENUE, SANTA CLARA, CALIFORNIA 95050

PROJECT DIRECTOR: RALPH STONE, PRESIDENT, RALPH STONE & CO., INC., ENGINEERS,
10954 SANTA MONICA BOULEVARD, LOS ANGELES, CALIFORNIA 90025

ESTIMATED TOTAL PROJECT COST:	$379,413
GRANTEE'S SHARE:	$126,471
FEDERAL SHARE:	$ 76,500 [01]
(BY YEAR OF PROJECT LIFE)	$ 94,100 [02]
	$ 82,342 [03]

DATE PROJECT STARTED: JUNE 1, 1966 **DATE PROJECT ENDS:** MAY 31, 1969

OBJECTIVES: To demonstrate the development and application of new and improved methods of solid waste disposal involving:

Landfill aeration. To demonstrate the use of aeration in sanitary landfills to provide more rapid stabilization, increased disposal capacity, and accelerated land reclamation for construction and other uses.

Compaction. To compare the densities achieved in sanitary landfills employing crawler and compactor types of compaction equipment and to evaluate each piece of equipment for overall landfill use.

I. Land Reclamation by Accelerated Stablization

PROCEDURES: The project is being carried out by Ralph Stone & Co., Inc., Los Angeles, California, over a 3-yr period. Test cells will be constructed and operated to demonstrate and compare conventional anaerobic sanitary landfill procedures with two types of aerated landfills and with their respective efficiencies in reclaiming land for industrial park use. One aerobic test cell will demonstrate the principle of composting, and the second will demonstrate the principle of controlled high-rate oxidation to achieve an oxidized residue suitable for final land disposal. The proposed program is divided into the following three phases: Phase 1. Demonstration of the method of reclaiming landfills by rapidly oxidizing the refuse to a residue and comparing the results of this process with the composting cell and the conventional anaerobic control cell. Phase 2. Refinement of this process, supplemented by additional studies. Phase 3. Demonstration of full-scale aerobic or other improved disposal methods, industrial park land reclamation, and development of appropriate cost and land reclamation maintenance experience.

PROGRESS TO DATE: Preparatory to initiating the large-scale field demonstration program for the rapid oxidation and stabilization of solid wastes, certain pilot plant facilities were established at the project engineer's laboratory to demonstrate improved volume reduction. The concepts employed included: (1) underground incineration; (2) rapid biological oxidation by controlled aeration, moisture application, heating, and natural thermophilic heat generation; (3) improvement of odor and particulate filtration and adsorption by varying the soil cover in terms of depth, type, moisture content and charcoal admixture; and (4) other chemical and physical methods for accelerated degradation.

Important pilot study findings are: (1) Biological oxidation required both controlled aeration and moisture. The pilot studies, although affected by the ambient environment, have improved operating technology and defined potential problem areas for the large-scale field demonstration. (2) The tests indicate that underground refuse incineration is technically feasible. Further pilot studies are required, however, to define practical limitations and optimize various parameters. A major advantage of the process is the effective oxidation owing to the high temperatures resulting from the insulating effects of the earth blankets and the long burning contact period with low air velocity and soil filtration, which minimize air pollution.

A test was conducted to determine the effects of excavation and recompaction of a normal anaerobic landfill in volume–compaction–density relationships at the Santa Clara landfill site. A year-old anaerobic cell was excavated, and the excavated solid waste recompacted into a new cell. The volume of solid waste excavated from the old cell was 530 cu yd, whereas the volume of recompacted waste in the new cell was 667 cu yd, indicating a net expansion of 25.6 percent. Settlement markers have been placed on a recompacted cell and other cells to determine settling rates. Characteristics of the recompacted cell and other cells will be determined as part of the overall test by core samples.

Two aeration cells have been constructed; each measuring about 50 × 200 ft at the bottom, 85 × 220 ft at the top, with a depth of about 17 ft. Aeration systems, consisting of a piping grid, blowers, valving and appurtenances, have been placed in the bottom of each cell.

Aeration Cell 1 has been filled with municipal rubbish and a mixture of municipal rubbish and commercial refuse. Cell 1 was first filled with municipal rubbish and aerated for 131 days. Temperatures in the cell rose rapidly after aeration was begun, and after 4 weeks, ranged from 190 to 200 F. An aerobic environment was maintained. There was no evidence of methane gas. Oxygen content within the cell ranged from 6 to 20 percent. Examination of the residue during transfer to residue Cell 7 indicated advanced decomposition. Vegetation was moist and soft with a black color. Much of the paper was brown, brittle, and appeared charred. Printing was, in many cases, illegible.

The volume of refuse in Cell 1, prior to transfer, was 4,430 cu yd. After transfer and recompaction in Cell 7, this same refuse occupied a volume of 3,340 cu yd, indicating a 25 percent volume reduction. Settlement in residue Cell 7 has been minimal, approximately 0.1 ft in 4 mo.

Cell 2 was filled with municipal refuse in the first cycle and aerated for 109 days. As in Cell 1, the internal aerobic environment was maintained. Maximum internal temperature was measured at 176 F. Upon residue transfer to Cell 12, a volume reduction of about 25 percent was measured.

Cells 1 and 2 were filled on the second cycle with a mixture of municipal rubbish and commercial refuse. Cell 1 was aerated for 95 days. The refuse residue is now being transferred to the final disposal cell. Cell 2 is still being aerated.

No problems due to odors, flies, or rodents have been experienced. The odors that did exist were not noxious and could be classified as sweet tobacco or faint barnyard. No complaints due to odor have been received. Two fires occurred over a 2-yr period. Spontaneous combustion may have resulted when aeration ceased and methane and high temperatures were allowed to develop simultaneously. During this period, many more fires were encountered in the operating anaerobic landfills.

Records were kept of all construction and operating costs related to the aeration process. Based on an assumed operational system, the additional cost for disposing of refuse by the aeration process, over and above the cost of ordinary landfill methods, was calculated to be $0.92 per ton of raw refuse, including excavation of residue cells, recompaction of refuse residue, and amortized capital and operation and maintenance costs for the aeration system.

The following preliminary conclusions have been developed by the consultant on the basis of the work performed to date: (1) the aeration process provided for accelerated decomposition of refuse into a stabilized residue; (2) following aeration, excavation and recompaction, refuse volume was reduced about 25 percent; (3) settlement of the semistabilized refuse residue has been minor; (4) vermin, flies, and other health hazards were nonexistent because of the high temperatures (180 F ±) and oxidation of the putrescible solid waste fraction of the refuse; (5) aeration maintained an aerobic internal environment and essentially eliminated methane gas production; (6) additional disposal cost to treat the refuse by this process is about $0.92 per ton of raw refuse, over and above the cost of ordinary landfill methods.

II. Landfill Compaction Studies

PROCEDURES: The relative effectiveness of a Caterpillar D–9, a rubber-tired FWD Wagner SF–17, a steel-wheeled FWD Wagner SF–17, and a Caterpillar 980 in compacting domestic and commercial refuse will be demonstrated.

PROGRESS TO DATE: A number of cells are being monitored for density results, including special compaction cells, cells at the regular landfill, and aeration cells described under Phase I. Surveys are made before, during, and after filling of each cell to determine incremental and total refuse volume. The weight of refuse delivered to each cell is recorded. Solid waste used to fill the cells is municipal rubbish collected in the city of Santa Clara and refuse delivered by commercial haulers.

Nine test cells have been completed to date: two by the rubber-tired FWD Wagner, four by the CAT D–9, two by the steel-wheeled FWD Wagner, and one worked by the steel-wheeled FWD Wagner and the CAT SC D–9. The Caterpillar 980 has not yet been delivered to the site, but is expected to arrive early in 1969. Comparative compaction studies will then be carried out with this equipment.

Cells 3, 4, 5, and 6 were designed specifically for compaction evaluation and were filled with municipal refuse. Aeration Cells 1 and 2 were first used for measuring refuse density and equipment efficiency, after which they were aerated for the previously described landfill stabilization demonstration. Cell 1 has been filled twice, once with municipal rubbish and once with commercial refuse and municipal rubbish. Cell 2 on the first filling was subdivided into 2S and 2N for comparative compaction studies and was filled with municipal rubbish. On the second filling of Cell 2, the entire cell was evaluated using commerical refuse and municipal rubbish.

The regular landfill operation is also being monitored during the final year of the study. Three cells have been completed: Cell I/II by the CAT D–9; and Cells III/IV and V by the steel-wheeled FWD Wagner. These cells were filled with a combination of commercial refuse, city rubbish, and refuse from public disposal. Normal landfill compaction procedures were used in these cells, and compacting time was often governed by the rate at which the refuse was received. In the special test cells, the compaction procedure was uniform.

The results to date on refuse density determinations have been summarized:

Cell no.	*Refuse type*	*Equipment used*	*Density (lb/cu yd)* *
1–1st Cycle	Municipal	CAT D–9	1208†
1–2nd Cycle	Commercial and municipal	CAT D–9 and Steel-wheeled FWD Wagner	1073
2N–1st Cycle	Municipal	CAT D–9	941
2S–1st Cycle	Municipal	Rubber-tired FWD Wagner	875
2–2nd Cycle	Commercial and municipal	Steel-wheeled FWD Wagner	1029
3	Municipal	CAT D–9	1049
4	Municipal	Rubber-tired FWD Wagner	1058
5	Municipal	CAT D–9	1094
6	Municipal	Steel-wheeled FWD Wagner	1278
I/II	Commercial and municipal	CAT D–9	924
III/IV	Commercial and municipal	Steel-wheeled FWD Wagner	996
V	Commercial and municipal	Steel-wheeled FWD Wagner	908

* Wet weight density exclusive of soil cover.
† Cell 1 was aerated while it was being filled.

During the study program, cost data were collected on operation and maintenance for each piece of compaction equipment. The following data represent the hourly cost for operation including depreciation. Labor is also included at $5.40 per hr.

1959 CAT D–9	1965 Rubber-tired FWD Wagner	Steel-wheeled FWD Wagner
$20.53/hr	$18.90/hr	$11.67/hr

Studies were conducted periodically to determine the time required for spreading and compacting refuse. The working rate in tons/hour was calculated from measured time and tonnage worked. Rates varied considerably. The data collected to date are summarized below.

	CAT D–9	Rubber-tired FWD Wagner	Steel-wheeled FWD Wagner
No. of individual observations	27	7	12
Total tons	1825	524	980
Total hours	28.6	5.1	13.9

Data from several of the higher-rate observations indicated that the observed mean peak rates were:

Mean peak rate (tons/hr)	CAT D–9	Rubber-tired FWD Wagner	Steel-wheeled FWD Wagner
	109	97	95

Based on the mean peak rates for spreading and compacting refuse and the hourly operating cost shown previously, the unit cost for working refuse was calculated.

	CAT D–9	Rubber-tired FWD Wagner	Steel-wheeled FWD Wagner
Net cost $/ton	0.19	0.19	0.12

Each piece of equipment is being evaluated as to its overall suitability for those tasks associated with landfill operation; *i.e.*, earth excavation, earth moving, embankment construction, road construction and maintenance, etc. When compared with the crawler type CAT D–9, which is quite versatile, the steel-wheeled and rubber-tired FWD Wagner have proven inefficient for these tasks.

The following preliminary conclusions have been developed by the consultant on the basis of the work performed to date: (1) The steel-wheeled FWD Wagner was effective for working refuse; when working municipal rubbish, approximately 20 percent higher refuse density was achieved with it than with the CAT D–9 or the rubber-tired FWD Wagner. Compaction control is required to realize better densities. (2) In the three regular landfill cells (Cells I/II, III/IV, and V), the steel-wheeled FWD Wagner achieved approximately the same refuse density as the CAT D–9. (3) The steel-wheeled FWD Wagner was the most economical for refuse compaction. The CAT D–9 and the rubber-tired FWD Wagner were about equal for refuse compaction. These cost figures were based on the actual operation and amortized capital costs of the equipment on the landfill. Two special factors that affected these costs were the older age of the CAT D–9 and the rapid tire wear and many punctures in the rubber tires of the FWD Wagner. (4) Preliminary data indicated that the CAT D–9 had the highest peak rate for spreading and compacting refuse and that the steel-wheeled FWD Wagner had the highest average rate for spreading and compacting refuse. (5) The CAT D–9 was far superior in performing landfill tasks other than working refuse; i.e., earth excavation, road work, etc.

PUBLICATIONS:

Stone, R., and E. T. Conrad. Land reclamation by accelerated stabilization. Preprint No. B-4. *In* Solid Waste Research and Development, II. Engineering Foundation Research Conference, Beaver Dam, Wisconsin, July 22–26, 1968. 4 p.

Stone, R., and E. T. Conrad. Landfill compaction studies. Preprint No. B-1. *In* Solid Waste Research and Development, II. Engineering Foundation Research Conference, Beaver Dam, Wisconsin, July 22–26, 1968. 4 p.

Stone, R., E. T. Conrad, and C. Melville. Land conservation by aerobic landfill stabilization. *Public Works*, 99 (12) :95–97, 138–139, Dec. 1968.

Stone, R., and M. Imail. Determining effects of landfill recompaction on a landfill. *Public Works*, 99 (1) :72–73, Jan. 1968.

Ralph Stone and Company, Inc., Engineers. Solid wastes landfill stabilization; an interim report. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. [145 p.]

Jefferson Parish West Bank refuse collection and disposal study

PROJECT TYPE: STUDY AND INVESTIGATION **GRANT NO.** D01–UI–00019
GRANTEE: JEFFERSON PARISH COUNCIL, PARISH OF JEFFERSON, NEW COURTHOUSE,
GRETNA, LOUISIANA 70053
PROJECT DIRECTOR: JEROME PEPPER, PRESIDENT, PEPPER AND ASSOCIATES, INC., 816 HOWARD AVENUE,
NEW ORLEANS, LOUISIANA 70113

ESTIMATED TOTAL PROJECT COST:	$40,973
GRANTEE'S SHARE:	$13,658
FEDERAL SHARE:	$18,315 [01]
(BY YEAR OF PROJECT LIFE)	$ 9,000 [02]

DATE PROJECT STARTED: JUNE 1, 1966 **DATE PROJECT ENDED:** NOV. 30, 1968

OBJECTIVES: To demonstrate how new or improved solid waste management techniques could solve a regional solid waste problem by developing a regional plan for the collection and disposal of solid wastes generated in the West Bank area of Jefferson Parish.

PROCEDURES, FINDINGS, AND RECOMMENDATIONS: The consulting engineering firm of Pepper and Associates, Inc., New Orleans, Louisiana, conducted the study. Results of this study have been incorporated within the New Orleans metropolitan area comprehensive solid wastes report (see summary for Grant No. D01–UI–00063).

The existing collection and disposal systems were analyzed to determine their efficiency, adequacy, and economics. The quantity of solid wastes generated in the study area was estimated by means of weighing programs. Recommendations were developed for a regional solution to the area's solid waste problem.

The West Bank of Jefferson Parish is comprised of that part of the Parish on the west side of the Mississippi River. Four separate garbage districts provide solid waste collection and disposal services for the unincorporated West Bank area. All of the districts put their revenues for this purpose into one basic fund, and the second district provides collection and disposal services for all. The cities of Westwego and Gretna provide separate municipal collection and disposal services for their citizens.

The solid wastes of the unincorporated area are currently being disposed of by a 90-ton-a-day incinerator located at Marrero and open burning at a dump. The city of Gretna also utilizes a 90-ton-a-day incinerator and an open burning dump, whereas Westwego is dumping and open burning all of its collected refuse. Both incinerators are obsolete, and open burning is being carried on in violation of Louisiana Board of Health regulation.

Based on his studies of the area's problems and present practices, the consultant has made the following principal recommendations:

1. A public relations campaign should be initiated to acquaint the public with the need for improved solid waste collection and disposal services, and to generally upgrade the image and status of the sanitation worker.

2. The four separate garbage districts should be consolidated into one overall district to serve the West Bank area. The disposal operations of Westwego and Gretna should be consolidated with that of the overall district.

3. As an immediate solution to the area's solid waste disposal problem, a 600-ton-per-day incinerator should be built on the site of the existing Marrero incinerator, to replace the two obsolete 90-ton-per-day incinerators. Incinerator residue should be disposed of by a sanitary landfill.

4. As a long-range disposal method, studies should be undertaken to evaluate the feasibility

Recreational use of waste incinerator heat

PROJECT TYPE: DEMONSTRATION GRANT NO. D01-UI-00020

GRANTEE: COUNTY OF BERGEN

PROJECT DIRECTOR: RICHARD L. NELSON, ASSISTANT EXECUTIVE ADMINISTRATOR, COUNTY OF BERGEN,
ADMINISTRATIVE BUILDING, HACKENSACK, NEW JERSEY 07601

ESTIMATED TOTAL PROJECT COST:	$4,374,065
GRANTEE'S SHARE:	$3,965,375
FEDERAL SHARE:	$ 200,000 [01]
(BY YEAR OF PROJECT LIFE)	$ 195,312 [02]
	$ 15,378 [03]

DATE PROJECT STARTED: JUNE 1, 1966 DATE PROJECT ENDED: OCT. 21, 1968

OBJECTIVES: To demonstrate that municipal refuse and other solid wastes can be incinerated without significantly polluting air or creating a public nuisance, and that incinerator waste heat can be used to operate recreational facilities.

PROCEDURES: A 600-ton-per-day incinerator will be constructed in Overpeck Creek Park, a recreational area which the county has been developing since the mid-1940's. The incinerator will be equipped with air pollution control devices adequate to eliminate any possible smoke and odor nuisance. A swimming pool and ice skating rink will also be built and waste incinerator heat utilized as a power source for their economical and efficient operation. Economics and practicability of the project will be evaluated.

The firm of B. B. Reilly and Associates, Ridgefield, New Jersey, will be retained to prepare plans and specifications for the incinerator and provide consulting engineering services in connection with its construction. The firm of Wank, Adams and Slavin, New York, New York, will be retained to provide architectural and engineering services required for the development of a preliminary project plan and analysis regarding the proposed recreational complex adjacent to the incinerator.

PROGRESS TO DATE: Contracts were signed with the two consultants in November 1966, and preparation of plans and specifications for the incinerator initiated. Preliminary plans have been completed and are being reviewed.

In January 1967, the township of Teaneck, New Jersey, filed suit seeking a court order to prevent the county from constructing the incinerator in Overpeck Creek Park. In October 1968, in view of extended litigation and problems arising therefrom, it was decided that further Federal support of the project could not be justified, and the project was terminated at the end of the 01 year.

California integrated solid waste management system

PROJECT TYPE: DEMONSTRATION GRANT NO. D01-UI-00021
GRANTEE: CALIFORNIA STATE DEPARTMENT OF PUBLIC HEALTH, 2151 BERKELEY WAY,
BERKELEY, CALIFORNIA 94704
PROJECT DIRECTOR: RICHARD F. PETERS, CHIEF, BUREAU OF VECTOR CONTROL, DIVISION
OF ENVIRONMENTAL SANITATION, STATE DEPARTMENT OF PUBLIC HEALTH

ESTIMATED TOTAL PROJECT COST:	$408,906
GRANTEE'S SHARE:	$151,426
FEDERAL SHARE:	$156,169 [01]
(BY YEAR OF PROJECT LIFE)	$125,311 [02]

DATE PROJECT STARTED: JUNE 1, 1966 DATE PROJECT ENDED: MAY 31, 1968

OBJECTIVES: To demonstrate how new or improved solid waste management techniques could provide a solution for a regional solid waste problem by conducting an intensive study and designing a system that will handle all urban, industrial, and agricultural wastes in a rapidly urbanizing 1,200-sq-mile area surrounding the city of Fresno; and to develop a technology for systematic study of the Fresno region and demonstrate that it may be applied to solve solid waste management problems in other similar regions.

PROCEDURES, FINDINGS, AND RECOMMENDATIONS: The project was conducted by Aerojet-General Corporation, El Monte, California, and Engineering-Science, Inc., Arcadia, California. The major portions of the study are summarized below from the consultants' final report.

Operating Conditions. Studies of the Fresno area were carried out to establish the physical characteristics of the region and conditions with reference to solid waste generation, collection, and disposal. The conditions examined included: (1) regional physical environment, (2) population (existing and projected), (3) land use (existing and projected), (4) waste loading (existing and projected), (5) legislative conditions, (6) existing management practices, (7) economic capacities and projections, (8) State Department of Health guidelines, and (9) technical restrictions.

These studies indicated that the 1967 regional population was about 396,000 people, 312,000 of whom lived in the region's communities and 84,000 in areas outside the communities. By the year 2000 the projected population of the region is to exceed 1,000,000, of whom 973,000 are expected in the communities and 83,000 outside. Agriculture is by far the largest land use. About 82 percent of the 770,000 acres in the region are currently used for this purpose, either for production of high-return crops, for use as irrigated pasture, for growing alfalfa or hay, or as native rangeland. By the year 2000, some 86 percent of the land area is estimated to be used in agriculture.

Estimates of solid waste generation in the region are as follows:

Type wastes	*Current (tons/yr)*	*Expected by year 2000 (tons/yr)*
Municipal	432,000	1,329,000
Industrial	256,000	508,000
Animal wastes and manures	1,012,000	2,100,000
Crop residues	777,000	1,305,000
Total	2,477,000	5,342,000

In general, laws and ordinances dealing with solid waste management in the region fall into three categories: (1) State legislation, which is, for the most part, enabling in nature; (2) county ordinances, which are implementing in nature and develop detailed methods to meet control objectives; (3) municipal legislation, which is directed toward detailed definition of methods, techniques, and financing of waste collection and disposal. The result of existing policies concerning solid waste collection and disposal has been the development of a heterogeneous system in the region, with practices varying between county and city and between cities. There is no standardization of equipment or routines, and a great deal of collection route duplication has existed. Steps to eliminate some of this duplication have recently been taken.

Performance and Ancillary Effect Scoring. This involved the development of a methodology whereby the effectiveness of various handling systems could be compared. "Performance scoring" and "ancillary effect scoring" procedures were devised for this purpose by applying systems analysis to the problem of integrating complex environmental relationships. The three principal elements involved in this development were:

1. The problems and effects to be controlled were identified. Originally, 82 different solid wastes were identified as occurring in sufficient quantities to create a problem. After being categorized as municipal, industrial, and agricultural wastes, the 82 types were finally reduced to 52 by combining certain similar wastes and eliminating others determined not to be of sufficient quantity to create serious environmental problems. The 19 major states or conditions in which solid wastes exist, or are likely to exist, in the region were then identified, e.g., unmanaged, spread on ground, open burning, plowed in ground, landfill. Thirteen various bad environmental effects associated with solid wastes in the various conditions were then identified, such as water pollution, air pollution, odor, safety hazards.

2. The basis of the performance scoring procedure was the postulation that the effectiveness of waste management procedures can be expressed in terms of the degree to which the system decreases the bad environmental effects of the waste.

Basic bad-effects scores were determined for each waste under each condition; experienced practitioners in the sanitary engineering and environmental health fields provided value judgments on the relative contribution of a given waste under a given condition to possible bad effects. A rating scale of 0 to 5 was used, with 0 indicating no significant contribution and 5 the highest contribution. A numerical relative-condition rating was then developed in a similar way; this reflected the bad-effects consequence of placing a unit quantity of the combined wastes in each of the conditions.

A numerical "relative importance factor" was developed to reflect the relative importance of each bad effect in terms of the type of area or subregion in which they occurred, i.e., whether the area was predominantly municipal, industrial, agricultural, or an interface area between municipal and agricultural. A numerical "relative contribution factor" was developed that represented a judgment as to what percent of each bad effect is caused by solid waste. An "influence coefficient" for each bad effect in each subregion was then obtained by multiplying the foregoing two factors and dividing the product by the sum of products for all bad effects in all subregions.

Total weighted bad-effects scores were obtained by (1) multiplying the basic bad-effects scores by the influence coefficient for each bad effect for each condition in each subregion and (2) adding the resulting scores for all bad effects in each condition. This resulted in a score representing the total bad effect of a unit quantity of a particular waste in a given condition in a particular subregion.

The performance score of any postulated waste management system is then the sum of the total weighted bad-effects scores for each waste in each condition in each subregion, multiplied by the tonnage of each waste in the particular conditions called for by the system being considered. Several of the conditions are basically transient, i.e., the wastes are in such conditions only for a short period of time. Compared with disposal conditions, in which the wastes attain a more or less permanent state, these transient scores are relatively low. Combining the two component scores would result in losing the effect of any improvement for transient conditions. Because it was judged that transient and disposal components are of equal importance to society, separate scores were maintained. In the final analysis of total system performance, these two component scores were individually evaluated and the results combined.

3. Scoring the ancillary effects provides a means of measuring the physical, social, and psychological effects of alternative waste management systems and their components as opposed to performance scoring of the effects of solid wastes. This becomes important when a number of systems under consideration have similar performance scores and costs. Ancillary effects can then be used to choose the optimum system from a group of nearly equal cost-effective systems. Two steps were involved:

(a) Identifying ancillary effects. Twelve ancillary effects were identified with reference to the physical components of solid waste management systems, e.g., noise, traffic interference, odor, unsightliness.

(b) Ranking and rating of effects. The relative importance and subsequent weighting factors for each of the effects were determined by procedures similar to those employed in the performance scoring procedure development previously described. The rankings of each effect were totaled for each subregion and ratings determined for the 12 effects by setting the highest totaled ranking score equal to 1.0 and rating the other effects in that subregion in proportion to their totaled ranking score.

Conceptual Design of Waste Management Systems for the Fresno Region. Basic approaches to solid waste management in the Fresno region were investigated, and a number of systems were delineated in sufficient detail to permit their evaluation in terms of cost, performance, and ancillary effects. Eighteen systems were postulated for managing municipal and industrial wastes and four methods for agricultural wastes. These were analyzed in sufficient detail to determine their capacities and effects in handling the projected amounts of various wastes expected to be produced in the year 2000.

Cost and Performance Analysis and System Selection. The scoring methodology and procedures described were applied to these systems. Scores for transient and disposal components were kept separate, and the percent improvement for each component for each proposed system were calculated, with the overall system improvement represented by the average of the improvement of the two system components. Costs of handling projected waste quantities for the year 2000 in the manner prescribed were calculated for each system. Minimum desirable performance and cost limitations for a solid waste management system for the year 2000 were determined.

A proposed system was selected for the Fresno region based on consideration of all technical constraints and of nontechnical constraints, i.e., legal, political, and sociological. The proposed system, a combination of the various transient and disposal systems, handles the different waste categories in a variety of ways and allows for an orderly transition over a period of time from the existing system. Costs in the year 2000 are estimated to be:

Municipal	**$42.7 million**
Industrial	**5.9 million**
Manures	**26.5 million**
Crop residues	**3.5 million**
Total	**78.6 million**

(1967 dollars)

The effectiveness of the proposed system is indicated by the calculated 84 percent improvement of environmental effects for the municipal–industrial portion and an improvement of 70 percent for the agricultural portion. In addition, the proposed system ancillary effect score of 17.24 is considerably lower than that of any of the previously postulated systems and falls within the cost benefit limits. These improvements, well above the program goals and within reasonable expenditures, are the result of a successful application of the postulated procedures.

Recommendations. As the first action to develop the proposed system concept, the consultants recommend the establishment of a regional agency with responsibility for overall conduct of the regional system. Various specific recommendations are also made for immediate actions and for medium to long-range actions. Recommendations concerning basic and applied research indicate specific areas requiring additional effort.

PUBLICATIONS:

Culver, B. D., and B. E. Walsh. Some aspects of systems engineering for waste management in California. *Arch. Environ. Health,* 17(3):377–382, Sept. 1968.

Aerojet–General Corporation. A systems study of solid waste management in the Fresno area; final report on a solid waste management demonstration. Public Health Service Publication No. 1959. Washington, U.S. Government Printing Office, 1969. [411 p.]

Quad-City regional solid waste program

PROJECT TYPE: STUDY AND INVESTIGATION **GRANT NO. D01–UI–00026**
GRANTEE: QUAD-CITY SOLID WASTES COMMITTEE,* CITY HALL, PATERSON, NEW JERSEY 07505
PROJECT DIRECTOR: FRANK P. FRANCIA, ROOM 53, CITY HALL, PATERSON, NEW JERSEY 07505

ESTIMATED TOTAL PROJECT COST:	**$151,300**
GRANTEE'S SHARE:	**$ 50,500**
FEDERAL SHARE:	**$ 50,000 [01]**
(BY YEAR OF PROJECT LIFE)	**$ 50,800 [02]**

DATE PROJECT STARTED: JUNE 1, 1966 **DATE PROJECT ENDED: DEC. 31, 1968**

OBJECTIVES: To demonstrate how new or improved solid waste management techniques could solve a regional solid waste problem by developing a regionalized program for solid waste disposal practices for a group of adjacent municipalities having a common problem of solid wastes handling, and to establish the administrative means for implementing the program developed.

PROCEDURES, FINDINGS, AND RECOMMENDATIONS: The committee's engineering consultant, Mr. William T. Ingram, performed much of the work carried out and also provided overall advisory services. Studies were made of the quantity and characteristics of solid wastes produced in each municipality. Meteorological investigations were carried out to evaluate the influence that incineration might have on air pollution in the area. Various methods of waste disposal were evaluated.

A final report is being prepared by the grantee. The following summary of major findings and recommendations has been abstracted from a draft of the proposed final report.

The Quad-City region, located in the southeasterly corner of Passaic County, New Jersey, is comprised of the cities of Clifton, Passaic, and Paterson, and the town of Wayne. Three of the four communities have contiguous boundaries, whereas the town of Wayne is separated from them by a narrow strip comprising a group of communities extending northeasterly from the Essex County line to the Bergen County line.

Basic information on each of the four communities was developed from earlier reports dealing with refuse collection and disposal requirements.

The official 1960 census was used as a basis for estimating per capita data. Four assays conducted in October 1966, and February, May, and August 1967 provided data on municipally collected solid wastes. Plant visits to 32 percent of the industrial establishments in the four communities provided information for projection of industrial waste data. Field visits provided information on construction/demolition production. Community public works departments and contract scavengers furnished data on periodic cleanup and street cleaning production. Visits to eight institutions provided onsite information on the handling of such wastes.

The four assay data indicate that the municipal waste production is 2.61 lb/capita-day. The industrial survey shows a Quad-City production of 3.05 lb/capita-day. Total waste production in the four communities amounts to an estimated 8.83 lb/capita-day. Production in the Quad-City community currently amounts to about 440 tons of municipal waste, 500 tons of industrial waste, and a total of 1,500 tons per day.

Thermal value of municipal waste runs about 3,300 Btu/lb in the field with about 30 percent moisture content and about 35 percent by weight inert or noncombustible materials based on laboratory assay.

Municipal waste includes approximately 44 percent paper and paper products, and 22 percent organic garbage. Glass, metal, and plastics account for about 18 percent of the production. By comparison, industrial waste composition includes about 43 percent paper and 5 percent organic food wastes. Glass, metal, and plastics amount to about 20 percent of the total.

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* Composed of representatives of the communities of Paterson, Passaic, Clifton, and Wayne, New Jersey.

Air ventilation studies have shown an influence of Garrett Mountain and the First Watchung Range on wind movements in the Paterson area. It is evident that further studies will be required at levels of stack height at any specific site location on the Passaic River Valley floor to establish dispersion characteristics of a plume associated with any burning process.

Geological studies indicate that any form of landfill must be so located that it will not be in contact with either ground water or bedrock, and preferably should be in areas of glacial deposit to avoid potential pollution of water resources.

Sixteen possible locations for treatment and/or disposal of the region's solid wastes have been considered, and nine have been investigated in some detail. The detailed investigation of sites is contingent on the methodology finally selected by the commission and the system selected for solid waste disposal demonstration. It appears that not more than four sites have the necessary attributes to meet both Quad-City requirements and the objections that might be raised.

Many alternate methodologies for the treatment and disposal of solid wastes were investigated. These included incineration, landfill, composting, compaction, long distance rail haul with transfer stations, high temperature combustion, grinding, and salvaging. Of these, three primary methodologies were selected for intensive investigation with the thought that alone or in combination, a complete processing system meeting the needs of the Quad-City community could be found. These included: (1) high temperature combustion, (2) long haul with transfer stations, and (3) sanitary landfill.

Appropriate auxiliary processes such as grinding, shredding, and compaction in support of the primary methodology and air cleaning equipment are considered to be part of the total demonstration program.

High-temperature combustion has been selected as the core disposal methodology for the study area. Rail haul is considered to be worthy, but not entirely adequate for the Quad-City need.

The Quad-City Solid Wastes Committee was established legally for a 3-yr term in July 1966. The committee has utilized the services of the legal counsels of each community in framing a document acceptable to all that would establish an authority to be known as the "Lower Passaic Valley Solid Wastes Management Authority."

Completion of the charter document made clear that a State legislative enablement act was required before the local ordinances could be officially acted upon. Such legislation was introduced as Senate No. 387 in February 1968, passed by both Houses, and signed into law by the Governor on Aug. 16, 1968.

Local community action on the charter is proceeding to bring the Lower Passaic Valley Solid Wastes Management Authority into being.

PUBLICATION:

Quad-City solid wastes project; an interim report, June 1, 1966, to May 31, 1967. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. [181 p.]

Solid waste disposal incinerator prototypes for specialized operations

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PROJECT TYPE: DEMONSTRATION **GRANT NO.** D01–UI–00029

GRANTEE: CITY OF BRIDGEPORT, CONNECTICUT, LYON TERRACE, BRIDGEPORT, CONN. 06604

PROJECT DIRECTOR: FRED SENGER, ASSISTANT CHIEF, 274 MIDDLE STREET, BRIDGEPORT, CONNECTICUT 06603

ESTIMATED TOTAL PROJECT COST:	$290,012
GRANTEE'S SHARE:	$ 96,670
FEDERAL SHARE:	$181,671 [01]
(BY YEAR OF PROJECT LIFE)	$ 11,671 [02]

DATE PROJECT STARTED: DEC. 1, 1966 **DATE PROJECT ENDED:** AUG. 31, 1968

OBJECTIVES: To demonstrate the feasibility and economic practicability of disposal of bulky solid wastes by means of an improved incineration process and to demonstrate the safety of equipment and techniques involved.

PROCEDURES: The city will construct a large brick incinerator approximately 15 ft wide and 75 ft long of the type commonly referred to as the "Detroit" brush burner for disposal of all types of bulky combustible solid wastes. Facilities will be provided for the recirculation of hot flue gases to the primary combustion chamber to determine if this will reduce burning time and improve stack effluent quality. On completion of construction, a test program will be conducted to evaluate performance characteristics of the incinerator. The types and amounts of waste materials that can be disposed of will be determined, and information about the relative hazards of disposing of volatile and/or explosive substances, which must now be buried, will be developed.

The firm of Leonard C. Mandell, Associates, Providence, Rhode Island, will provide consulting engineering services in connection with the design and construction of the project and will plan and conduct the testing program with the assistance of the University of Bridgeport's Engineering Department.

PROGRESS TO DATE: At the end of the 01 year, the propriety of continued grant support for this project was reevaluated by the Bureau of Solid Waste Management. It was determined that there had been an unauthorized change in emphasis of project objectives and that this, together with excessive delays, had resulted in the project's having lost the uniqueness and merits which provided a basis for its original approval. On Nov. 20, 1968, the grantee was so advised and informed that funds originally reserved for the 02 year of the project were being reassigned and that the unexpended portion of the 01 year's funds was to be returned to the Government. Currently, at the request of the grantee, the technical aspects of the project are being further discussed.

Gainesville compost plant

PROJECT TYPE: DEMONSTRATION **GRANT NO. D01–UI–00030**

GRANTEE: GAINESVILLE MUNICIPAL WASTE CONVERSION AUTHORITY

PROJECT DIRECTOR: HERBERT W. HOUSTON, GAINESVILLE MUNICIPAL WASTE CONVERSION AUTHORITY, 1600 S.E. 13th ROAD, P.O. BOX 1152, GAINESVILLE, FLORIDA 32601

ESTIMATED TOTAL PROJECT COST:	**$1,723,715**
GRANTEE'S SHARE:	**$ 574,572**
FEDERAL SHARE:	**$ 250,000 [01]**
(BY YEAR OF PROJECT LIFE)	**$ 625,000 [02]**
	$ 274,143 [03]

DATE PROJECT STARTED: JUNE 1, 1966 **DATE PROJECT ENDS: DEC. 31, 1969**

OBJECTIVES: To demonstrate the reliability, suitability, economic feasibility, and sanitary and nuisance-free operation of a recently developed high-rate, mechanical composting system for the disposal of municipal refuse from a medium sized community.

PROCEDURES: A compost plant designed to process 20 tons of refuse per hr will be constructed to dispose of municipal refuse from the City of Gainesville, the University of Florida, and Alachua County. Facilities will be provided for incorporating either raw or digested sewage sludge into the compost. The plant will utilize the Metropolitan Waste Conversion System previously used at Largo, Florida, and currently in use at Houston, Texas.

Records will be kept of the amounts of refuse and sludge processed, compost produced, salvaged materials, and other noncompostable components. A complete cost analysis of the operation will be developed, including operation and maintenance costs of major items of equipment. The efficiency of the equipment will be evaluated, and operating characteristics and maintenance requirements will be determined. Necessary insect and rodent control measures will be instituted. Health records of employees will be maintained. Biological, bacteriological, and chemical and physical characteristics of the raw, partially digested, and finished compost will be determined.

Overall mechanical design criteria for the plant will be developed by the Metropolitan Waste Conversion Corporation, Wheaton, Illinois. Plant design and associated consulting engineering services will be provided by the firm of Reynolds, Smith and Hills, Jacksonville, Florida. Technical and scientific evaluation of the project will be planned and supervised by Environmental Engineering, Inc., Gainesville, Florida.

PROGRESS TO DATE: Three reports have been prepared by the grantee detailing progress through August 1968. These are in the process of being reproduced by the Bureau of Solid Waste Management for widespread distribution. A preliminary report on progress during September to December 1968 is being prepared. The following summary has been developed from information in these reports.

By the end of December 1967, construction of the plant was basically completed. Briefly, this plant employs the following process. Incoming refuse is weighed, deposited in a receiving hopper, and conveyed to the picking table by a conveyor system that loosens the material, making it easier to separate. The pickers remove cardboard, paper, rags, metal, and bulky items; the first three items are sold as salvage. The refuse is then ground in a Centriblast Disintegrator from which it is discharged to a ballistic separator that removes the heavier materials (metals) and lighter materials (paper and plastics). The remaining material receives a second grinding in a Williams hammermill. Sewage sludge and/or water can be added at the discharge end of this grinder. The material is mixed by screws, and remaining ferrous material is removed by a magnetic separator. The mixed material is biologically degraded into a relatively stable compost in two digester tanks, each 320 ft long by 20 ft. wide. The digesters provide 6 days of detention time at plant design capacity. During the digestion period, air is periodically passed through the perforated bottoms of these tanks. Following digestion the compost is reground in two specially built rasps and stockpiled.

During an operational shakedown period, which began on Jan. 4, 1968, and lasted until the beginning of April, refuse from the city of Gainesville was processed. This gave plant personnel a chance to become familiar with the operation, correct difficulties, and make necessary adjustments. Many problems were initially encountered with the various items of equipment, but these were, for the most part, corrected during this period. The principal problems were noted in two main areas—at the primary grinder and the tripper area at the digester tanks.

Early in April, the plant began operating at full capacity and received refuse from the city of Gainesville and Alachua County. By April 12, some 150 tons per day were being received. In June, the University of Florida began delivering its refuse to the plant. From this time until the end of 1968, the plant was essentially in full operation with the exception of two extended shutdown periods, one in June and the other during July and August, as explained later.

One of the principal problems encountered was the quantity and nature of trash that the city brought to the plant. The machinery in the plant was basically designed to take all garbage and trash that consisted of leaves, grass clippings, shrubbery prunings, and small branches 2 to 3 in. in diameter and not over 5 ft long. During May and June, separate trash deliveries were made to the plant on certain days. Some trash was also mixed in with the regular refuse. Tree branches 6 to 8 ft long, oak logs up to 24 in. in diameter, together with whole tree root systems, refrigerators, washing machines, and the like were being received, all entwined with moss. When alone, the smaller items of trash that the machinery was designed to handle presented no problem, but when these were mixed with the larger items, sorting difficulties arose. The sorters at the picking table found it practically impossible to pull these masses apart before they entered the primary grinder, which then bogged down under the load. Frequently, the picking conveyor had to be stopped and the material pulled off and hauled to the landfill. This necessitated considerable overtime, then a change to a two-shift operation with an increased working crew. These unforeseen developments resulted in a plant shutdown from July 19 to August 17 because of a shortage of operating funds. During this period, a reorganization of the plant operating crew was effected insofar as the number of men and pay scale were concerned. This trash problem has continued, and worsened in October when Gainesville changed its method of pickup to a combined garbage and trash collection on a daily basis. Inordinately large amounts of bulky items consequently have to be pulled off the sorting belt and hauled to landfill with other noncompostables.

A second major problem area has been the primary grinder (Centriblast). Considerable downtime has been required for various modifications to this item; the longest such period was the last week of June. This item is being returned to the manufacturer. Evaluations have been made of Williams, Gondard, and Eidal grinders to replace the Centriblast. No final decision has been reached on which make of grinder will be purchased.

During May and June, a few complaints were received of odors emanating from the plant. The odor-producing situations were corrected, and since then the operation has continued without production of objectionable odors.

A summary of data concerning plant operation during 1968 shows, on a monthly basis, the amounts of total refuse received for processing, compostables in the refuse, and compost moved to final storage.

	Refuse (total tons)	*Compostables (tons)*	*Compost (tons*)*	*Plant operated (days)*
May	2,448	2,052	1,022	22
June	2,450	1,910	2,594	18
July	1,478	1,248	838	12
August	293	261	0	5
September	2,361	1,844	1,066	22
October	2,534	1,832	1,158	23
November	2,313	1,665	927	20
December	2,526	1,749	889	21

* Estimated tonnage moved from end of bulk storage belt to permanent stockpile.

To date, compost has been produced in bulk form only. An estimated 8,762 tons of compost has been moved from storage at the end of the process line to a permanent stockpile. Of this total, 967 tons have been given to the city of Gainesville and 552 tons to the university; 980 tons have been sold, principally to the citrus industry. During the last 4 mo of 1968, sales approximately doubled over those during the previous 4-mo period. Most of the sales effort to date has been directed at the citrus industry, based on the concept that an in-depth approach to one market area at a time generally produces better results than superficial attempts to develop many outlets. At present, customers pay from $14.25 to $16.75 per ton (wet weight basis), which includes delivery and application by specially developed trucks and trailers. These prices are for relatively small volumes, and it is believed they would be lower, perhaps $7.00 to $8.00 per ton, for large volume sales.

Total plant operating costs for the 4-mo period September to December 1968 averaged $19,363.22 per mo, or $7.96 per ton of solid waste received.

To date, paper is the main waste constituent salvaged. During the last 4 mo of the year, the amount of paper salvaged was increased by adding another baler, increasing efficiency of the pickers, and processing greater amounts of refuse. During this time, the amount of salvaged paper increased from 114 to 184 tons per mo. Percentage recovery increased from 4.8 to 7.3 percent of the weight of incoming refuse. The paper is sold to users of low-grade paper stock who manufacture several grades of paperboard used in the building materials industry and to roofing mills. These sources pay $19 to $20 per ton, F.O.B. the plant, for salvaged paper.

Rags are now being salvaged because of the interest indicated by one customer. One bale has been produced, although it does not appear there is any large quantity to salvage. The customer has reported that the quality of the material is good and he can use all that the plant can produce. Rags are sold at a price of $18 per ton, F.O.B. the plant.

Possible markets for salvaged tin cans have been investigated, but at present, there apparently is no suitable market for these in Florida. Consequently, they are being disposed of at the landfill along with noncompostables and trash.

In early June, use of sewage sludge as a moistening agent was begun. Ninety gal of sludge with a 4 percent solids content were added to each ton of compostable material being processed. Major problems encountered were the difficulty in controlling the amount of moisture being added and the jamming of solenoid valves because of rags in the sludge. At the end of June, use of sludge was discontinued in favor of city water. During the last 3 mo of the year, 194,600 gal of digested sludge were mixed into 5,246 tons of compostable materials, a rate of approximately 37 gal per ton. On occasion, the large amount of sand in the sludge would plug up the sludge lines, at which time city water would be used. Sludge was used about 90 percent of the time, and no major operating problems were encountered when digested sludge was used at this rate.

The technical evaluation of the process has been hindered by lack of established and proven sampling and analytical methods. Progress made to date is summarized as follows:

Carbon was diminished during the digestion of solid waste and the curing of compost. Although this reduction can be assumed, previously it was not conclusively demonstrated at the Gainesville Compost Plant. Nitrogen apparently increases during waste digestion. The C/N ratio of waste decreased with increasing treatment time and generally followed the BOD reduction. Preliminary results indicate that the BOD test is satisfactory for determining waste stability or degree of treatment; COD and volatile solids tests were not satisfactory for this purpose. A method was developed for sampling solid waste. Good sampling is necessary before meaningful data representing waste before and after treatment can be obtained. The method employs a Fiberglas bag to contain the waste during treatment and to ensure its retrieval after treatment. Thus, virtually the same sample can be analyzed before and after treatment, and the results are much less erratic than random sampling procedures. A similar bag was used for the successful demonstration of coliform die-off during composting.

A health hazard is suggested by the finding of viable particles in the atmosphere surrounding the plant in the size range that can penetrate the lungs. The uncertainties of clinical research will tend to preclude any correlation between this potential hazard and actual lung diseases in the plant workers. This suggests the use of laboratory animals that can be exposed to dusty atmospheres and then sacrificed for careful examination. Plans are being made to strengthen the medical and the insect and rodent control programs.

PUBLICATION:

GAINESVILLE MUNICIPAL WASTE CONVERSION AUTHORITY, INC. Gainesville Compost plant; an interim report. Cincinnati, U.S. Department of Health, Education, and Welfare, 1969. [345 p.]

San Jose/Santa Clara County
solid waste disposal demonstration project

PROJECT TYPE: STUDY AND INVESTIGATION **GRANT NO. D01–UI–00035**
GRANTEE: CITY OF SAN JOSE, CITY HALL, 801 NORTH FIRST STREET
PROJECT DIRECTOR: RAYMOND C. MILLER, DIRECTOR OF PUBLIC HEALTH, CITY OF SAN JOSE,
SAN JOSE, CALIFORNIA 95110

ESTIMATED TOTAL PROJECT COST:	$186,000
GRANTEE'S SHARE:	$ 62,000
FEDERAL SHARE:	$ 39,000 [01]
(BY YEAR OF PROJECT LIFE)	$ 85,000 [02]

DATE PROJECT STARTED: JUNE 1, 1966 **DATE PROJECT ENDED:** DEC. 31, 1967

OBJECTIVES: To demonstrate how new and improved solid waste management techniques, using a systems analysis approach, could solve the solid wastes problem in the San Jose metropolitan area and Santa Clara County.

PROCEDURES, FINDINGS, AND RECOMMENDATIONS: The FMC Machinery/Systems Group, FMC Corporation, Santa Clara, California, carried out a systems analysis for the study area. A coordinated information collection and exchange effort was developed between the FMC Corporation, the California Department of Health, and the University of California, each of which supplied mutually useful information concerning various aspects of the solid wastes problem in the study area.

The project has been completed, and a final report has been prepared by the FMC Corporation. The major findings and recommendations resulting from the study and presented in the report are as follows.

A survey was conducted of solid waste sources and quantities in Santa Clara County. Projections of the annual solid wastes quantities expected in the years 1970, 1980, and 1990 were made by source and geographic location.

Potential incineration facility sites were selected for system cost and environmental evaluation. Service areas were defined for these selected facility sites when combined in various numbers and ways to handle the solid wastes of the county. Estimated refuse hauling costs were computed for these various multisite configurations.

On the basis of estimated hauling costs, a final 10 of the disposal-system configurations were selected for estimated facility-operating-cost evaluation and combined (or system) cost evaluation. An environmental evaluation was made of the disposal facility sites involved in these 10 disposal configurations.

During the solid waste system survey, a survey was also made of resource recovery processes as possible supplements to the incineration disposal system

FINDINGS AND CONCLUSIONS: Survey results indicate that solid waste quantities are much larger than suspected and will continue to increase in San Jose and Santa Clara County. Future projections of the aggregate solid wastes (which include those from agriculture, demolition and construction activities, canneries, sewage treatment plants, etc., as well as those from domestic, commercial, and other industrial sources) are alarming particularly when related to the existing sanitary landfill disposal capacities and the difficulties encountered in the attempted acquisition of new landfill sites.

If new solid waste disposal methods are not employed to substantially reduce waste volumes in the future, and if no new landfill sites are acquired, exhaustion of the existing landfill capacities would probably occur in the early 1970's. The lives of these sites may be prolonged, however, by going to additional lifts (adding layers of refuse on top of the existing fill).

By 1970, the annual solid waste production is expected to be 3.4 million tons, and over 13.8 million cu yd (in the loose or noncompacted condition). The total annual solid waste quantities by 1990 are expected to increase to 4.6 million tons and 19.6 million cu yd—increases of about 35 and 42 percent, respectively, over the 1970 estimates. Though waste quantities from agriculture are expected to decrease sharply, waste quantities from all other major waste source categories (residential, industrial, etc.) are expected to show large increases.

Central incineration of almost all solid wastes, except demolition debris, would significantly prolong the lives of the existing landfill sites. The residue from incineration would require disposal by landfill, but the residue volume would only be about 10 percent of the preincinerated refuse volume.

Incineration would bring about other important effects on landfill operations including: (1) reduction of landfill operating costs, (2) reduction of fill site pollution potential, and (3) increase in ultimate uses of fill site (ability to support structures, etc.).

Analysis and evaluation of selected potential incineration facility sites and system configurations (various Sira-type facility combinations) on the basis of estimated disposal facility operating costs, refuse hauling costs, and environmental factors such as land use compatibility, accessibility, expansion potential, complaint potential, etc., indicated the following:

1. A single incineration facility just south of Agnew is the lowest estimated cost incineration system configuration.

2. The estimated costs of disposal by incineration would increase as the number of facilities serving Santa Clara County increase because the estimated increases in facilities operating costs would be more than the estimated savings in hauling costs.

3. An incineration facility adjacent to the San Jose–Santa Clara Water Pollution Control Plant would be the most suitable on the basis of an environmental evaluation. The estimated annual system disposal costs for a single facility at this site would be less than 4 percent higher than the costs for the Agnew location.

4. Adding a transfer station to move south county refuse from collection trucks to large capacity trailers for long haul to a north county incineration facility is more economical than adding another incineration facility.

The survey of resource recovery processes indicated that caution should be exercised in any attempt to recover materials from solid wastes finally reaching disposal sites. Ferrous metal recovery and steam generation, however, would be accomplished as a part of the Sira system of refuse disposal.

Composting has been beset by operational as well as marketing problems. The market for compost continues to be of doubtful viability.

No experience has been established with large-scale pyrolysis operations, and, therefore, the operational reliability and market potentials for pyrolysis products (char and low-grade fuel gas) are uncertain.

RECOMMENDATIONS: Although disposal by incineration in Santa Clara County would be more costly than disposal by sanitary landfill at this time, it is not clear how long this will continue to be true. The estimated cost comparison would depend upon how difficult it becomes to obtain suitable nearby fill sites capable of handling garbage and other putrescibles; however, cost intangibles associated with aesthetics and the effects upon our environment, depending upon the criteria, indicate an overall desirability of disposal by incineration.

For the above reasons, the overall program plans, calling for engineering, construction, and demonstration of a full-sized Sira-type refuse disposal facility, should be carried through.

The purpose of the facility would be to demonstrate the effective disposal of solid wastes including municipal refuse, sewage sludge, animal manures, cannery wastes, pesticide residues, etc., while avoiding problems of air and water pollution.

These studies have indicated that a Sira-type demonstration facility should be capable of handling at least 400 tons per day. Estimated costs for the city and/or county to construct and demonstrate this facility have been developed.

In September 1967, Sira Corporation announced plans to build a privately financed disposal facility of 400-ton-per-day capacity for the Green Valley Disposal Company of Los Gatos, California.* It is therefore recommended that San Jose and the county await the completion of this unit and evaluate its operation before proceeding further.

It is further recommended that following effective demonstration of the Sira-type system, a countywide implementation program be planned specifying a schedule of when and how much incineration capacity should be installed at the most suitable location adjacent to the San Jose–Santa Clara Water Pollution Control Plant. This implementation schedule would be governed in part by the estimated depletion dates of the various sanitary landfill sites and the availability of new sites.

Further evaluation should also be made to integrate the following with the Sira-type refuse disposal facility: (1) Sewage treatment and refuse disposal through incineration in a boiler of undigested sewage sludge, and steam utilization in the sewage treatment plant. (2) Demolition debris, abandoned vehicle reduction (pulverization), and segregation facility with the burning of combustibles in Sira-type facility. (3) Pilot composting, pyrolysis, and hydrolysis processes.

The above work phase should then be concluded with final installation plans and specifications. Construction could begin immediately following this phase.

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* Reported in the Los Gatos, California, *Times Observer*, Sept. 28, 1967.

Erie County refuse disposal project

PROJECT TYPE: STUDY AND INVESTIGATION **GRANT NO.** D01–UI–00035
GRANTEE: ERIE COUNTY DEPARTMENT OF HEALTH
PROJECT DIRECTOR: THOMAS C. WEST, DIRECTOR, DIVISION OF ENVIRONMENTAL HEALTH,
ERIE COUNTY DEPARTMENT OF HEALTH, 606 WEST 2nd STREET,
ERIE, PENNSYLVANIA 16507
ESTIMATED TOTAL PROJECT COST: $43,997
GRANTEE'S SHARE: $14,666
FEDERAL SHARE: $22,665 [01]
(BY YEAR OF PROJECT LIFE) $ 6,666 [02]
DATE PROJECT STARTED: JUNE 1, 1966 **DATE PROJECT ENDS:** MAY 31, 1969

OBJECTIVES: To demonstrate how new or improved solid waste management techniques could solve a regional solid waste problem by conducting a study that will: (1) identify and evaluate the separate solid waste collection and disposal systems now being operated in Erie County and develop a proposed countywide system for solid wastes handling, and (2) determine the sociological problems associated with the proposed establishment of refuse disposal sites and develop and implement a program to overcome adverse public attitudes.

PROCEDURES: The consulting engineering firm of Michael Baker, Jr., Inc., Rochester, Pennsylvania, has provided services in connection with the first project objective. The present solid waste disposal practices of the political subdivisions of the county will be determined. Several alternative disposal methods for a countywide disposal system will be considered and possible disposal sites located. The possibility of integrating existing systems, or portions thereof, into the proposed countywide system will be considered. Capital and annual operating costs for the recommended system will be estimated. Proposed methods of financing and administration will be presented.

The County Department of Health will develop and implement a public information program in connection with the second project objective.

PROGRESS TO DATE: All of the field work required to develop a proposed countywide solid waste disposal plan has been completed, and the consultant's final report has been prepared. Major conclusions and recommendations developed by the consultant in his report are as follows:

1. Existing solid waste disposal practices within the county are completely inadequate and incapable of serving the county over a long-term period. There is an immediate need for additional solid waste disposal facilities in the county to cope with the current and future needs of an expanding population and with an ever-increasing volume of solid waste. A centralized or countywide approach to the solid waste problem is the only logical solution since independent and/or separate actions by individual municipalities, if attempted, would only result in prohibitive and unrealistic costs for solid waste disposal in many county areas.

2. It is not practical to utilize sanitary landfill exclusively as a *long-term* solution to the county's solid waste disposal problem, primarily because of the lack of suitable large land tracts required. Consequently, incineration in conjunction with landfill of the incinerator residue is proposed as the major method of solid waste disposal for the Erie County area for the indefinite future.

3. The county should undertake a phased course of action in accordance with the following schedule: (a) acquiring or reserving large land areas for solid waste disposal purposes

around the urban areas of the county and acquisition of the site for the proposed incinerator; (b) continuing efficient use of existing landfill sites and acquiring additional suitable landfill sites of sufficient area to provide for satisfactory disposal of county refuse up to 1971, at which time the proposed incinerator may be in operation; (c) investigating, by the city of Erie, the practicality of increasing the burning capacity at its existing incinerators to reduce the volume of wastes now being landfilled; (d) constructing the proposed county incinerator facility; (e) closing existing dumps and landfills, except for disposal of noncombustible wastes and retaining landfills serving county population centers beyond economical haul distances to the incinerator; (f) continuing current area collection practice employing local municipal and/or private collectors or continuation of both; however, collection practices should be standardized throughout the county by proper collection and legislative action of all participating political subdivisions; (g) following construction of the new incinerator, abandoning the existing Erie garbage incinerator and continuing operation, but eventual phasing out, the Erie West Side trash incinerator.

4. Many research efforts have been directed to the problem of solid waste disposal with the help of the Solid Waste Disposal Act of 1965, and many are in various stages of development. Some recent developments in this field hold promise for possible application in the Erie area and may warrant further future investigation. These are variations of the sanitary landfill method of disposal and, briefly, are as follows: (a) refuse compaction, particularly as being developed by the Japanese, followed by refuse disposal for land reclamation purposes in marshy areas or along lake shores. (b) Investigation of transportation and exportation of solid waste originating in the Erie area by rail and/or express highway to abandoned strip mine areas lying to the south of Erie County.

The county has formed a solid waste advisory committee to review the recommendations of the consulting engineer and to initiate a public education program. The committee has conducted an active program to date. Television, radio, and newspaper releases have been used to inform the public about solid waste problems in the county. Numerous talks have been given to civic clubs, and exhibits have been shown to further make the public aware of the problem. A questionnaire survey of a random sampling of the population indicated that incineration is the best known means of solid waste disposal (91.2 percent of the people questioned knew what incineration was), sanitary landfill was second (46.8 percent knew what sanitary landfill was), and composting was next (35 percent knew what composting was). The survey also indicated that 93.5 percent of the people would support the governmental officials in their effort to solve the garbage and refuse problems in Erie County. The educational program is continuing, guided by the results of the questionnaire.

The Solid Waste Advisory Committee is reviewing the program and laying the framework for the establishment of a County Solid Waste Management Authority that will be necessary for carrying out the eventual program. During the past year, a new sanitary landfill site was approved in Erie County that meets the requirements of the State and County Departments of Health. Another site is also presently under consideration. Hopefully, these sites will be operated by the proposed County Solid Waste Management Authority. The new landfill sites will serve the interim period until the comprehensive countywide plan can be implemented and will possibly be included in the comprehensive plan.

The committee is also investigating all other methods of solid waste disposal that might be feasible. The consultant in his report discussed the possibility of the county using the sanitary landfill method of solid waste disposal. Estimated capital operation and maintenance costs of this method were less than those for incineration, but the consultant did not recommend its use, principally because of his conclusion that suitable land areas are not available within reasonable distances of the heavily developed county areas. Large tracts of land have been located that the county feels would be satisfactory for landfill operations, however, and the possibility of utilizing this method of disposal is being studied by the committee.

Oklahoma County solid waste disposal study

PROJECT TYPE: STUDY AND INVESTIGATION — **GRANT NO.** D01–UI–00036

GRANTEE: OKLAHOMA CITY–COUNTY HEALTH DEPARTMENT

PROJECT DIRECTOR: D. C. CLEVELAND, DIRECTOR, DIVISION OF ENVIRONMENTAL HEALTH, CITY–COUNTY HEALTH DEPARTMENT, 331 WEST MAIN STREET, OKLAHOMA CITY, OKLAHOMA 73102

ESTIMATED TOTAL PROJECT COST:	$70,830
GRANTEE'S SHARE:	$23,609
FEDERAL SHARE:	$13,767 [01]
(BY YEAR OF PROJECT LIFE)	$19,687 [02]
	$13,767 [03]

DATE PROJECT STARTED: JUNE 1, 1966 — **DATE PROJECT ENDS:** MAY 31, 1969

OBJECTIVES: To demonstrate how new and improved solid waste management techniques could solve a regional solid waste problem by preparing a long-range plan for the collection and disposal of solid wastes to best serve the needs of Oklahoma County, and promoting necessary legislation for the establishment of an area-wide solid wastes collection and disposal district.

PROCEDURES: The project is being conducted by staff members of the Oklahoma City–County Health Department. Consulting engineering services are being provided by Professor Raul Zaltzman, University of West Virginia.

The records of each municipality will be examined to determine the area served by the collection system, ownership of the system, cost and frequency of collection, and amount and character of wastes collected. Costs of extending existing systems to serve all municipal and rural population will be estimated. Advantages of an area-wide collection system vs individually operated systems will be compared.

A survey of existing disposal sites will be made to determine ownership, amount, and character of wastes received, cost and effectiveness of operation.

Commercial, industrial, and salvage operations will be surveyed to determine the amount, character, and method of disposal of solid wastes they produce.

A plan will be developed for the most effective solid waste collection and disposal system to serve the needs of the county. If an area-wide system or systems can be economically organized and operated, necessary legislation will be promoted to permit operations on this basis.

PROGRESS TO DATE: Existing solid waste collection and disposal facilities have been surveyed. Collection systems range from very sophisticated and efficient types in the larger cities to no service at all in the smaller communities. Pickup frequency varies from twice weekly to once a month. Disposal is mainly by open dumps or improperly operated landfills. Open burning is practiced at most disposal sites, and at many homes, businesses, and schools. Burning operations are properly controlled in only a few instances, resulting in hazardous fires at many locations during dry seasons. Many private haulers are operating, the great majority being unlicensed.

At present, production of solid wastes in the county is estimated as being 440,000 tons per yr, which is approximately 100,000 tons per yr more than in 1960. Projections indicate that by 1985 this rate will increase to over 700,000 tons per yr.

A mathematical model has been designed to study and optimize the operational characteristics of all the factors involved in the operation of an area-wide solid waste storage, collection, and disposal system.

Various methods of solid waste disposal have been investigated. Sanitary landfill appears to be the most feasible. Several proposed landfill sites have been selected.

The grantee has begun work on the final report for the project.

Incinerator no. 5. Phase I—special studies. Phase II—design

PROJECT TYPE: STUDY AND INVESTIGATION **GRANT NO.** D01-UI-00038

GRANTEE: DEPARTMENT OF SANITARY ENGINEERING, GOVERNMENT OF THE DISTRICT OF COLUMBIA

PROJECT DIRECTOR: WILLIAM F. YOUNG, CHIEF, PROJECT DEVELOPMENT & ENGINEERING BRANCH,
DEPARTMENT OF SANITARY ENGINEERING, GOVERNMENT OF THE DISTRICT OF
COLUMBIA, 14th & E STREETS, N.W., WASHINGTON, D.C. 20004

ESTIMATED TOTAL PROJECT COST:	$484,284
GRANTEE'S SHARE:	$161,428
FEDERAL SHARE:	$ 62,802 [01]
(BY YEAR OF PROJECT LIFE)	$260,054 [02]

DATE PROJECT STARTED: JUNE 1, 1966 **DATE PROJECT ENDS:** MAY 31, 1969

OBJECTIVES:

(1) To determine the feasibility of incorporating special features into the design of a proposed 800 ton per day incinerator to provide facilities for performing demonstration and research projects related to advancing the science of solid waste disposal, reducing air pollution, improving plant operation, and establishing parameters for design and operation of future incinerator installations and allied equipment; and (2) to study, investigate, and develop a design for a solid waste incinerator installation, together with satellite equipment capable of reducing the volume of all categories of combustible solid wastes for disposal in sanitary landfills.

Phase I—special studies

PROCEDURES: Six separate studies will be conducted for the proposed incinerator by Day & Zimmerman, Inc., Engineers and Architects, Philadelphia, Pennsylvania, as follows:

Study of municipal incinerator effluent gases. The effect of certain incinerator variables on the type and quantity of effluent gas emissions and their effect on emission control equipment will be studied. The performance of various available types of emission control equipment will be evaluated. Estimated capital and operating costs of acceptable types of emission control equipment for the proposed incinerator will be developed.

Heat recovery. Fuel characteristics of refuse and combustion air requirements based on fuel analysis will be investigated. Relative characteristics of waste heat recovery boilers will be examined. Estimates will be made of capital and operating costs for each type of boiler and for a conventional incinerator without waste-heat equipment so that incremental cost additions may be determined.

Metal recovery. Recovery of metal before incineration will be considered. Suitable procedures for processing furnace residue to separate ferrous metals will be reviewed. Capital and operating costs will be estimated for a metal recovery facility sized to process residue from the proposed incinerator.

Control laboratory. The various types of laboratory and monitoring equipment available and appropriate to perform the desired physical and chemical analyses and continuous recording of plant operating conditions will be studied. Estimates of capital costs and space requirements for recommended items will be made.

Size reduction of oversize burnable waste. Various types of equipment available for size reduction of large combustible materials will be studied. Capital and operating costs for a recommended installation will be estimated.

Size reduction of bulky metal objects by compression presses. Types and capacities of presses available for the reduction of bulk volume of noncombustibles will be investigated. Capital

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and operating costs for a compression press installation will be estimated.

PROGRESS TO DATE: The foregoing studies were completed during the first year of the project and a final report prepared by the consultant. Pertinent features of each study are summarized below:

Study of municipal incinerator effluent gases. This report considers the significant characteristics of municipal incinerator effluent gases. A discussion of the chemical constituents of incinerator stack emissions is presented. The effluent gases were found to be organic and inorganic in nature in both gaseous and solid states. Some constituents were found to be toxic and corrosive when present in appreciable amounts. Various types of emission control equipment were evaluated, including electrostatic precipitators, air scrubbers, mechanical cyclones, and baghouse filters. The electrostatic precipitators preceded by mechanical cyclone collectors were recommended because of their high efficiency and ability to meet stringent air pollution control standards. Although high-energy scrubbers were considered acceptable from a performance standpoint and lower cost, aesthetic objections to the vapor plume and probable thermal pollution of the water source ruled out their application at this location.

Heat recovery. Several apparently successful European applications of steam boilers to municipal refuse incinerators have prompted consideration of similar installations for American incinerators. American operating experience with incinerator heat recovery boilers has been limited, and no outstanding pattern of successful operation has been established.

To evaluate this disparity between European and American practice, a comparison is made of typical refuse compositions, refuse heating values, and applications of heat recovery equipment to incinerator furnaces.

Consideration is given to both refractory and water-cooled furnaces, their effect on excess air requirements, and the economics of the sale of steam or other methods of heat dissipation.

For the proposed incinerator, the application of a boiler plant capable of burning 800 tons of refuse per day with four incinerator furnaces is considered. The economics of the proposed plant do not justify the installation of heat recovery equipment.

Can-metal recovery. This study reviews the possibilities of recovering ferrous metal from municipal refuse either before or after incineration. The study indicates that the only major existing market for this material (after incineration) is the copper mining industry. This market is currently being satisfied.

The capital investment required and the operating costs to be expected for an installation to recover ferrous can metal from the residue of a new 800 tons per day incinerator have been estimated. Because of the low price obtainable for recovered can metal and the high cost of freight to the one sizable market, it is concluded that facilities of this type should not be included in the new District of Columbia incinerator project.

Control laboratory. This report itemizes instrumentation and laboratory equipment and their estimated installed costs. The equipment was selected to permit normal monitoring of plant operations and to aid in the performance of tests for developing incinerator design and operating techniques. Equipment was grouped into four categories: recording and indicating equipment for incinerator operation; physical laboratory equipment; chemical laboratory equipment; and monitoring equipment for test and development studies. The total cost of recommended equipment and space is estimated at $447,675.

References to existing test procedures are presented to aid in the proper application of the equipment items suggested.

Size reduction of oversize burnable waste. This report considers various methods of size reduction of oversize burnable waste including the use of specially designed incinerators and shredders.

A shredder of the hammermill type is recommended for installation at the proposed new incinerator site. A metal separator is also recommended because passage of excess metal through the furnace is not desirable. The installation cost is estimated to be approximately $667,000 and annual operating costs are estimated to be $125,000.

Size reduction of bulky metal objects by compression presses. This report discusses methods for municipal disposal of bulky metal objects. The use of compression presses to reduce the volume of these objects was investigated and found to be acceptable under certain conditions. Capital investment estimates and evaluation of operating costs for metal presses installed at two separate locations are reported. The amount of metal to be handled in the District of Columbia is not sufficient to achieve a good economy of operation. The alternative use of outside contractors or metal shredding as a potentially more economical solution is recommended.

Phase II—design

PROCEDURES: The consulting engineering firm of Day & Zimmerman, Inc., Philadelphia, Pennsylvania, will make a comprehensive investigation of the design features, and design a continuous feed incinerator and appurtenances. Investigations will be conducted to determine the performance of special equipment (e.g., mechanical collectors and electrostatic precipitators) and to develop design modifications that will make them suitable for use in municipal solid waste incineration. Size reduction of large combustible objects by a large hammermill will be investigated, and, if proven feasible, will be incorporated into the design. Special control and research laboratory facilities will also be included in the design of the incinerator so that a thorough evaluation can be made of the refuse incinerator while operating under all conditions. Included in the study will be an investigation of procedures and actions that a municipality must take for interim disposal of solid wastes during design and construction of a permanent facility. The design of this incinerator also will demonstrate how to incorporate the solid waste facility of a single jurisdiction into a long-range regional plan.

PROGRESS TO DATE: Design of the incinerator is proceeding, and the project is expected to be completed on schedule.

PUBLICATION:

Day & Zimmermann, Engineers and Architects. Special studies for incinerators; for the Government of the District of Columbia, Department of Sanitary Engineering. Public Health Service Publication No. 1748. Washington, U.S. Government Printing Office, 1968. 80 p.

Maricopa Countywide solid waste disposal

PROJECT TYPE: STUDY AND INVESTIGATION **GRANT NO.** D01–UI–00039

GRANTEE: MARICOPA COUNTY HEALTH DEPARTMENT

PROJECT DIRECTOR: JOSEPH J. WEINSTEIN, DIRECTOR, DIVISION OF ENVIRONMENTAL HEALTH SERVICES,
MARICOPA COUNTY HEALTH DEPARTMENT, 1825 EAST ROOSEVELT,
PHOENIX, ARIZONA 85006

ESTIMATED TOTAL PROJECT COST:	$80,955
GRANTEE'S SHARE:	$26,985
FEDERAL SHARE:	$30,000 [01]
(BY YEAR OF PROJECT LIFE)	$ 9,970 [02]
	$14,000 [03]

DATE PROJECT STARTED: DEC. 1, 1966 **DATE PROJECT ENDS:** MAR. 31, 1970

OBJECTIVES: To demonstrate how new or improved solid waste management techniques could solve a regional solid waste problem by developing a solid waste disposal system and plan for countywide reference and use, and by developing a protocol and timetable for putting the plan into effect.

PROCEDURES: Types and quantities of solid wastes now being produced in the county will be determined and existing disposal methods identified. The interrelationship between current collection and disposal practices will be studied. Estimates of population growth to the year 2000 and parallel projected increases in solid waste production will be made. An analysis will be made of possible solutions to the solid waste disposal problem of the county. A recommended countywide solid waste disposal plan will be developed. This will take into account necessary funding arrangements, recognize and recommend required modifications of law, and describe needed intergovernmental cooperative agreements and other methodology that will assure a feasible plan.

The firm of John Carollo Engineers, Phoenix, Arizona, is providing consulting engineering services and is responsible for attaining a majority of the project objectives. Engineering and other personnel of the County Health Department are contributing to the study by making supplementary surveys of the availability and suitability of certain land for landfill purposes and by conducting topographic and soil exploration studies as needed.

PROGRESS TO DATE: The consultant has prepared an interim report of project progress based on general studies made during the first year of the project. Activities during this period included research into historical and current technical literature on solid wastes disposal methods and records, and visits to major disposal sites in Texas and California including composting plants, incinerator plants, and sanitary landfill operations. Written and photographic records were accumulated for all municipal disposal operations in Maricopa County. Conferences were held with public works directors and engineers concerned with disposal operations in the county. Some special tests were made by cities to determine valid density relations to be used in planning. Main findings presented in this report are summarized below.

In 1960, one-half of Arizona's population lived in Maricopa County, which comprises 8.1 percent of the State's land area. Five major cities in the county have a population of 30,000 or more: Phoenix and Glendale, Mesa, Scottsdale, and Tempe, which are located in the Phoenix metropolitan area. The total 1960 population of these five communities was 523,600, or approximately 80 percent of the total county population of 663,500. Corresponding estimated populations for the year 2000 are 2,400,000 and 3,000,000.

About 86 percent of this population is served by sanitary landfill disposal facilities, about 3 percent by open dumps, whereas the remaining 11 percent is dispersed in rural areas where organized collection service is not available. Land reclamation, in conjunction with sanitary landfills, has been practiced to a limited extent. Cooked garbage was being fed to hogs at 67 licensed locations. A central junk automobile processing plant was being operated near Kyrene.

Municipal collection of residential solid wastes is common to all cities and towns except Paradise Valley. Commercial solid wastes are generally collected by municipal forces, the major exception being Phoenix where noncity vehicles haul about one-half of all solid wastes delivered to city sanitary landfills. Measurements and records of haul and disposal operations in the county are generally inadequate to provide a complete factual basis for analysis and management. Phoenix has a good basic record of disposal at three landfills, which provided the most reliable data for analysis and use in this study. Disposal of solid wastes was reported by eight communities or their private firm haulers to be as follows:

Place	*Lb/cap-day*
Phoenix	5.1
Chandler	4.1
Mesa	3.2
Paradise Valley	4.2
Scottsdale	3.8
Wickenburg	4.0
Sun City	2.1
Tempe	3.3

Based on available information, the daily production rate of residential, commercial, and industrial solid wastes was estimated to be 2.5 lb per capita for Sun City and Youngtown; 5.5, for Phoenix; and 4.5, for all other urban areas in Maricopa County. Agricultural solid wastes are generated from the raising, processing, and packaging of vegetable and meat products. Measurements were not made of the total agricultural waste production in the county, which are generally disposed of onsite by application to land. Major disposal problems would no doubt arise upon termination of this practice; however, these were not considered in the current study. At present, the greater part of the solid waste problem concerns residential, commercial, and industrial waste production in urban areas.

Solid waste disposal by means of sanitary landfill is the basic method proposed in this report. Regional programs are proposed as the most efficient and least expensive means of providing sanitary disposal service to the smaller, as well as the larger, communities. Under this plan the county would be divided into seven regions, each having its own system of collection and disposal. County government participation in these regional programs would be required.

Activities are underway to implement portions of the above-mentioned report. Negotiations are proceeding for the acquisition of a suitable site for development and operation as a model sanitary landfill. Investigations are also proceeding as to the feasibility of solid waste disposal by rail haul, possibly to abandoned mine sites.

PUBLICATION:

John Carollo Engineers. Maricopa County; an interim report on a solid waste demonstration project. [Cincinnati], U.S. Department of Health, Education, and Welfare, 1969. [318 p.]

Solid waste disposal by incineration, using an incinerator with characteristics requiring minimum control equipment

PROJECT TYPE: DEMONSTRATION **GRANT NO.** D01–UI–00040

GRANTEE: CITY AND COUNTY OF SAN FRANCISCO, DEPARTMENT OF PUBLIC WORKS, ROOM 260,
CITY HALL, SAN FRANCISCO, CALIFORNIA 94102

PROJECT DIRECTOR: CLIFFORD J. GEERTZ, CITY ENGINEER, ROOM 359, CITY HALL, SAN FRANCISCO,
CALIFORNIA 94102

ESTIMATED TOTAL PROJECT COST: $644,870
GRANTEE'S SHARE: $214,956
FEDERAL SHARE: $117,193 [01]
(BY YEAR OF PROJECT LIFE) $155,527 [02]
$157,194 [03]

DATE PROJECT STARTED: APRIL 1, 1967 **DATE PROJECT ENDS:** MAR. 31, 1970

OBJECTIVES: To develop, design and construct a municipal-type refuse incinerator with operating characteristics that would meet the requirements of the several air pollution control districts in the Pacific coastal area with a minimum of control equipment.

PROCEDURES: The project will be conducted by the technical staffs of the Department of Public Works of the City and County of San Francisco and the Bay Area Air Pollution Control District. Technical advice and assistance will be furnished by the consulting firm of Garretson–Elmendorf–Klein–Reibin, Architects and Engineers, San Francisco, California.

Incineration process features that will be studied, developed, fabricated, and tested include: (1) a mechanical grate capable of functioning with a minimum of underfire air; (2) multiple chamber furnace without conventional bridge and/or curtain wall; (3) a secondary chamber located so as to obtain turbulence and complete burnout of gases; (4) air jets for inducing turbulence and mixing at the entrance to the secondary chamber; and (5) a fly-ash scrubber, which, when used in conjunction with the other components, would produce an effluent capable of meeting air pollution regulations. Design factors will be evaluated by testing under varying conditions of operation. Construction, maintenance, and operating cost information will be developed for a unit capable of handling 100 to 150 tons per day.

PROGRESS TO DATE: The consulting firm of Garretson–Elmendorf–Klein–Reibin, Architects and Engineers, developed and submitted to the city a proposed design for the incinerator. Ernest B. Willis, retained by the city as a mechanical engineering consultant, assisted and advised with the details of the engineering and design of a grate capable of functioning with a minimum of underfire air.

In December 1968, the city decided that the most practical and feasible method of disposing of its solid wastes would be by rail haul, and the necessary plans are being developed. Because of this development, the city will, in the near future, request termination of this project.

Building an amphitheater and coasting ramp with municipal refuse

PROJECT TYPE: DEMONSTRATION GRANT NO. D01–UI–00045
GRANTEE: CITY OF VIRGINIA BEACH, VIRGINIA
PROJECT DIRECTOR: CHARLES S. KILEY, DIRECTOR OF PUBLIC WORKS, CITY HALL, COURTHOUSE DRIVE, VIRGINIA BEACH, VIRGINIA 23456

ESTIMATED TOTAL PROJECT COST:	$459,138
GRANTEE'S SHARE:	$153,046
FEDERAL SHARE:	$147,219 [01]
(BY YEAR OF PROJECT LIFE)	$102,246 [02]
	$ 56,627 [03]

DATE PROJECT STARTED: JAN. 1, 1967 DATE PROJECT ENDS: DEC. 31, 1969

OBJECTIVES: To demonstrate the feasibility of constructing an above-grade sanitary landfill with municipal refuse to serve as an amphitheater and coasting ramp.

PROCEDURES: Consulting services and assistance are being provided by the Old Dominion College, School of Engineering, and the State Health Department.

The project site area will be thoroughly surveyed and prepared. The land where the fill is to be placed will be excavated to a depth somewhat above ground water and a standard sanitary landfill will be started. Refuse will be placed, compacted, and covered each day with a 6-in. layer of earth. When earth from the original cut is used up, earth from a borrow pit will be utilized. When the project is completed, this pit will be allowed to fill with water to form a lake. Top soil, piled separately for use as a final cover material, will be placed on the side slopes and covered with vegetation as the fill rises. At the time the project begins, a nursery will be started to grow plants that will be used to stabilize the banks. The fill will be constructed so that at completion an amphitheater and coasting ramp will be created. This project has been designed to dispose of the refuse from a city of about 150,000 population.

PROGRESS TO DATE: The hill has been built up with compacted refuse and cover material to a height of 14 ft, 9 ft above the original ground surface and 4 ft below, at the excavated base. The planned hill will have a total height of some 60 ft.

Since Apr. 1, 1967, all refuse from Virginia Beach (estimated population 150,000) has been placed in the hill. Work has proceeded on a 6 day per week schedule. Incoming refuse is weighed, and other information such as truck identification, type of refuse, weather, and temperature is also obtained. These data are recorded on porta punch computer cards for analysis. During the past year, an average of 268 tons of refuse has been received during each operating day. The monthly averages have varied from a high of 341 tons per day to a low of 183 tons per day.

A FWD Wagner compactor is used to spread and compact the refuse. A bulldozer is used for spreading cover material and as a backup for the compactor when it is being repaired. Cover material is excavated by a dragline and loaded into dump trucks by a front-end loader. The original dump trucks have been replaced with larger, more powerful units to eliminate difficulties in negotiating grades on the hill, particularly in bad weather. Slopes have also been reduced to assist in overcoming this problem.

Personnel from Old Dominion College are monitoring the project. Five wells have been sunk adjacent to the hill, and chemical and biological tests are being run to determine the effects, if any, of leaching on ground water. Settling plates, gas probes, and thermocouples have been installed. Vertical probes have been

Development of construction and use criteria for sanitary landfills

PROJECT TYPE: STUDY AND INVESTIGATION **GRANT NO.** D01-UI-00046

GRANTEE: COUNTY OF LOS ANGELES, HALL OF ADMINISTRATION, 500 WEST TEMPLE STREET,
LOS ANGELES, CALIFORNIA 90012

PROJECT DIRECTOR: JOHN A. LAMBIE, COUNTY ENGINEER, COUNTY ENGINEERING BUILDING,
108 WEST SECOND STREET, LOS ANGELES, CALIFORNIA 90012

ESTIMATED TOTAL PROJECT COST:	$303,500
GRANTEE'S SHARE:	$101,270
FEDERAL SHARE:	$ 66,330 [01]
(BY YEAR OF PROJECT LIFE)	$ 73,300 [02]
	$ 62,600 [03]

DATE PROJECT STARTED: JAN. 1, 1967 **DATE PROJECT ENDS:** DEC. 31, 1969

OBJECTIVES: To demonstrate methods of improving solid waste disposal procedures by: (1) development of methods to control gas movements from existing and new landfills; (2) development of methods to control leachate discharging from existing and new landfills; and (3) development of a "code" for use in controlling construction of buildings on completed sanitary landfills.

PROCEDURES: The actual investigations are being made jointly by Engineering-Science, Inc., Arcadia, California, and the county's technical staff.

First year. Solutions will be provided to the problem of decomposition gas movement from sanitary landfills into surrounding soil and ground waters. These solutions will be the result of studies of gas flow measurements, geologic configurations, soil properties, subsidence rates, and gas-control devices. *Second year.* Subsidence in sanitary landfills will continue to be investigated. The investigations will include (1) a review of subsidence data obtained from other on-going solid waste disposal projects; (2) surveys of existing structures located on landfills in Los Angeles and San Francisco areas; (3) evaluation of settlement data; (4) studies of the effects of settlement on structures, utilities, and roadbeds; and (5) recommendation for construction of above facilities on sanitary landfill sites. *Third year.* The findings from the first and second years will be combined and evaluated to provide specific design and construction guidelines for sanitary landfills in urbanized areas. Solutions to subsidence problems will be developed, pilot experiments to demonstrate the advantages of volume reduction before landfilling will be conducted, salvage of materials will be studied, and a control and inspection system for landfill operations will be formulated. Throughout the study, specific proposals for demonstration projects will be formulated.

PROGRESS TO DATE: A report covering the work performed during the first year of the project (Jan. 1 to Dec. 31, 1967) has been prepared by the grantee. The following material has been taken from this report:

Sanitary Landfill Practice. Construction and operation of sanitary landfills was reviewed as practiced by the City of Los Angeles, City of Burbank, County of Orange, County Sanitation Districts of Los Angeles County and private operators.

Selection of Landfill Sites, and Scope and Results of Studies. Eleven sanitary landfills were selected for study, and general soil and geologic information was obtained for these landfills. Ten of the sites were chosen to analyze gas production and movement. The eleventh site was used for settlement analysis only. A total of 338 gas probes were installed around these ten landfills with the majority of the probes being placed approximately three feet deep. Some were located at deeper depths, varying from 5 to 16 feet, because of particular soil conditions and the desire to analyze gas concentration at greater depths. In addition, a total of 50 probes, installed by others at certain of the sites prior to this study, were incorporated into the sampling schedule for this program.

A minimum of two series of samples were obtained and analyzed from these probes. Using the results of these analyses, contours of equal methane or carbon dioxide concentration were plotted around each landfill. Correlations were developed between the pattern and extent of gas movement and the nature of soil formations, the topography and the effect of existing gas control devices.

Survey monuments were established at four selected sites and background data were collated on land subsidence at these and other sanitary landfills.

Gas Movement Through Porous Media. Laboratory experiments were conducted to test the suitability of natural soils for gas barrier membranes. Four soils with different particle size distributions were separately tested in a laboratory diffusion column at two levels of moisture content and three inflow gas pressure conditions. Using an analytical solution for the differential equation governing the flow of gases through porous media, diffusion-dispersion coefficients for each soil were determined. These data provide a basis for calculating the rate of flow of gases through these soils under different conditions of soil moisture, compaction, and gas pressure. This rate, in turn, provides a basis for determining the relative degree of effectiveness of these soils as gas barrier membranes.

Design of Field Gas Barriers and Control Devices. Field experiments on gas barrier and control devices were designed; these designs envision the implementation of gas control systems at three of the sites in the Los Angeles area. One of the systems (at Site No. 1) includes the excavation of five, 60-ft-deep wells about 150 ft from the finished landfill. The deep-well system will operate on the basis of combined gas suction and air flushing. Another control system (at Site No. 5) consists of an asphalt-type membrane installed under a greenhouse constructed directly upon the fill. A third system (at Site No. 8) uses a 10-ft-deep interceptor trench to be excavated along one of the boundaries of the fill. This trench will be backfilled with No. 2 gravel and the intercepted gasses will be transferred to a "tiki" burner through a horizontal 4-in. perforated pipe and vertical risers spaced at 300-ft intervals.

The effect of Sanitary Landfills on Groundwater Quality. Sanitary landfills may produce water quality degradation if proper construction practices are not followed. Water quality degradation can occur through: (1) percolating water carrying away liquids of undesirable quality which were contained within the fill; (2) percolating water dissolving undesirable waste fractions; (3) gases generated within the fill diffusing downward and outward to be dissolved in groundwater. The degree of degradation depends upon the quality of waste generated and dissolved which, in turn, depends on such landfill conditions as type and state of fill material, physical and chemical conditions within the fill, surrounding soil characteristics, and proximity of groundwater.

Completed Sanitary Landfill Land Uses. Land uses on completed landfills within the study area include athletic fields, botanical gardens, golf courses and driving ranges, parks, parking lots, playgrounds, salvage and storage yards, and trailer parks. Most of the completed landfills were fulfilling their planned purposes and have provided beneficial uses for the completed landfill property. Severe damage to surface structures and subsurface structures were observed in those landfills where sound engineering practices had been disregarded during construction of the landfill or where no effort had been made to design for differential settlement and the combustible gases produced in the landfill.

Code Considerations for Construction and

Use of Sanitary Landfills. Existing regulations governing sanitary landfill construction and operation do not fully recognize dangers inherent in the subsurface production and movement of methane gas. This deficiency could be alleviated by requiring that a full investigation be made by a qualified engineer. Conclusions by the engineer should consist of an evaluation of methane production potential, possibility of methane movement into adjacent lands and recommended methods of control.

Conclusions

1. Production of gases in a landfill is related to decomposition of the various materials placed therein. The amount of moisture present in the landfill greatly affects the rate of decomposition. Available data indicate that gas production and movement can take place many years after completion of a sanitary landfill.

2. Gases generated in a sanitary landfill, consisting predominantly of methane and carbon dioxide, may travel a considerable distance from the fill, depending on the nature of the soil formations around the fill. Among the landfills selected for this study, methane concentrations of 10 percent were detected below the ground surface at a distance of 600 to 700 ft from the fill at Site No. 1 and 600 ft from the fill at Site No. 8. Both of these landfills were constructed in depressions resulting from gravel mining operations. The natural soils around these fills consist of coarse materials and are classified as gravelly sand. On the other hand, at Landfill Site No. 6 where the soil formations consist predominantly of fine materials such as silt and clay, shallow probes at a distance of 200 ft from the fill detected only negligible methane concentrations.

3. Gas movement from sanitary landfills takes place by molecular diffusion and convective gas transport mechanisms. Positive gas pressures of from 2 to 3 in. water have been registered in or adjacent to sanitary landfills. The rate of this transfer is determined by the permeability characteristics of the soil formations around the fill so that, for example, different flow rates may result, under identical pressure and concentrations, from two landfills, one in a gravel pit and another in a tight soil formation.

4. The practical result of the laboratory experiment is the demonstration that an effective gas barrier can be formed around landfills that are constructed in gravel pits by the construction of a membrane of fine textured soils under and around these fills. In the case of landfills constructed in areas where soils of sufficiently high clay or silt content predominate, there may be no need for installation of artificial membranes. Provisions for venting the landfill will assist in preventing buildup of gas pressure and reduce possible gas movement.

5. Gas movement from sanitary landfills in this geographical area has not resulted in serious fire and explosion hazards to buildings located on the landfills and neighboring areas. In order to alleviate potential problems where, by monitoring, gases are shown to exist steps should be taken to assure adequate venting under and in all buildings on or near the landfill so that explosive gases can not be trapped or accumulated in the buildings.

6. Existing building codes do not recognize a need to protect structures, located adjacent to refuse fills, from the possible hazards of horizontal gas movement.

7. Gas control measures, if required, would be easier to provide before or during construction of the landfill.

8. Buildings, surface improvements, and subsurface structures can suffer extreme damage and destruction if constructed on sanitary landfills without proper regard for the potential differential settlement.

9. Further research and study is needed to ascertain the seriousness of gas movement away from landfills and its effect on improvements and land use of adjacent areas.

An interim report for the second project year (Jan. 1 to Dec. 31, 1968) has been prepared by the grantee; the summary of progress and findings given below has been taken from this report.

Summary

Progress and Findings of Second Project Year. Work of the first year was continued to gather additional data for analysis and to augment that already obtained. This involved (1) continued sampling of gases at certain research sites for analysis and evaluation of gas concentrations and movement resulting from seasonal weather conditions; (2) installation, testing, and evaluation of the effectiveness of gas control and barrier devices; (3) continued measurement of subsidence; and (4) laboratory analysis of the gas permeability of natural soils for suitability as gas barrier membranes.

A laboratory experiment was conducted to study leaching and leachate production of refuse samples taken from two completed landfills and of two synthetic fresh refuse samples mixed in the laboratory. Principal parameters of interest were the rate of leachate production and the total quantity of leachate that can be expected per unit measure of a landfill. The samples were systematically leached in the laboratory, and leachates were analyzed for total dissolved solids, chemical oxygen demand, hardness, alkalinity, pH, organic and ammonia nitrogen, chlorides, sulfates, and nitrates.

Available information on uses and problems associated with sanitary landfills was collected by mailing out questionnaires, visiting completed sanitary landfills upon which developments have been constructed, and interviewing selected experts. A total of 272 short-form and 41 long-form questionnaires were returned. Nineteen completed and reused sanitary landfill sites were visited and seven experts were formally interviewed.

A laboratory experiment for investigating subsidence characteristics of decomposing refuse materials was started and will continue into the third year. When the complete results of this experiment become available, the development of a method for predicting the maximum probable amount of subsidence will be attempted.

Subsidence in a sanitary landfill has been related to the nature of the refuse, compaction, and volume reduction caused by biological decomposition, saturation, and leaching. The experiment introduced these and other variables under aerobic and anaerobic conditions in the forms of paper, garbage, garden waste and wood, metal, glass, ceramics, rags, plastics, and inert soil. These were synthesized and compacted in a programmed sequence. Monitoring of weight, temperature, and subsidence of decomposing refuse materials will be maintained during the course of this experiment. Consolidation tests will be made when almost all of the decomposable organic materials have been decomposed.

Conclusions. Gas production studies during the two-year study have verified that there are urgent reasons to trace the movement of gases from existing research sites and to study and evaluate the effectiveness of control and barrier devices. The results indicate that hazardous situations may be identified, observed, and controlled.

Subsidence monitoring alone has not yielded sufficient data to establish predictability of subsidence. Laboratory testing, which is expected to correlate subsidence with its causes, has not progressed to the stage of decomposition of the refuse materials beyond which subsidence predictions can be quantified.

Gas control systems tested during the second year of the study have reduced methane concentrations within the area of influence of the system.

A natural soil sample was tested for suitability as a gas barrier membrane. The results indicate that further testing would yield sufficient quantification to enable the design of membranes that would operate predictably. The range of different soil types should be tested.

Leachate tests carried out on landfill refuse samples have revealed the potential amounts of leachable materials. Total dissolved solids was used as an index for determining the quantity of solutes that can be leached from refuse fills. Significant reduction and change in leachate concentrations may take place during the travel of the solvent water through soil materials before reaching the ground-water bodies. Filtration, ion exchange, and adsorption are among the major processes affecting the composition of leachates percolating through the soil formations. Information on the geology of the strata between ground-water and the leaching landfill is necessary for estimating the amount of direct, rather than potenital, pollution.

The reuse of completed sanitary landfills as real estate is prevalent. Many of the improvements constructed are experiencing problems caused by differential settlement. Others have gas, odor, and nuisance problems. The most frequent single reported planned use was for parks and recreation. A significant number of other uses include industrial, commercial, and residential buildings. Reports on the suitability of sanitary landfill for development include favorable comments and opinions but emphasize the need for detailed attention to preparations for preventing and alleviating conditions caused by the problems.

Of direct consequence to neighboring developments is the hazard of migrating gases. Some reports of gas control installations indicate general awareness of the hazard.

Factors that affect the degree of nuisance are percentage of organic debris, moisture content, daily soil cover, weather conditions, final soil cover, and age of fill.

Structural requirements for safe construction of all improvements depend on the horizontal and vertical stability of the landfill. The requirements may be achieved by special attention to application of basic physical principles as they are affected by interaction with the sanitary landfill. Differential settlement and horizontal displacement effects must be anticipated in the choice of methods, materials, and applications.

Detailed precautions are necessary to prevent the intrusion of gases into confined or occupied areas of buildings. Utility installations may create pathways for gases to follow. These pathways must be sealed off and vented at manholes, vaults, basements, and underfloor areas.

The major problems associated with sanitary landfills are gas, leachates, subsidence, odors, and nuisance. Some good practices suggested to solve these problems include (a) establishment of the base of the active portion of the sanitary landfill a safe distance above high ground-water elevation until gas and leachate barriers are demonstrated to be reliable; (b) preplanned construction and maintenance of the sanitary landfill; (c) provision for drainage of the surface and subsurface, and planned maintenance of all grading and piping; (d) installation of fencing for security and to catch blowing papers; (e) control of lifts and daily cover; (f) wetting, which is advised; and (g) well-compacted and contoured final earth cover drained to proper drainage facilities.

Differential settlement is a special subsidence condition and special techniques applied to underground installations may minimize the effects of this condition. These include (a) placement of pressure lines in a zig-zag line; (b) placement of utility lines in a trench; (c) choice of flexible materials; (d) ball and socket joints where possible; (e) placement of a protective arch over the utilities lines to prevent contact with subsiding earth above and on the sides; (f) special installations in casings; (g) steeper slopes for gravity lines; (h) easily removable plugs in drop manholes to facilitate visual inspection; (i) special design conditions at points where utilities enter structures; and (j) special, flexible ditch design with overlapping expansion joints.

PUBLICATION:

COUNTY OF LOS ANGELES, DEPARTMENT OF COUNTY ENGINEER. Development of construction and use criteria for sanitary landfills; an interim report. Cincinnati, U.S. Department of Health, Education, and Welfare, 1969. [267 p.]

Use of abandoned strip mines for solid waste disposal in Maryland

PROJECT TYPE: DEMONSTRATION GRANT NO. D01–UI–00048
GRANTEE: MARYLAND STATE DEPARTMENT OF HEALTH
PROJECT DIRECTOR: WILFRED H. SHIELDS, JR., CHIEF, DIVISION OF SOLID WASTES, MARYLAND STATE DEPARTMENT OF HEALTH, 2305 N. CHARLES ST., BALTIMORE, MARYLAND 21218

ESTIMATED TOTAL PROJECT COST:	$205,457
GRANTEE'S SHARE:	$ 79,960
FEDERAL SHARE:	$ 28,597 [01]
(BY YEAR OF PROJECT LIFE)	$ 50,352 [02]
	$ 47,369 [03]

DATE PROJECT STARTED: NOV. 1, 1966 DATE PROJECT ENDS: OCT. 31, 1969

OBJECTIVES: To demonstrate the feasibility of using abandoned strip mines for sanitary landfills.

PROCEDURES: The project is being conducted by personnel of the Division of Solid Wastes, Maryland State Department of Public Health, in cooperation with county and municipal governments.

An abandoned strip mine in Allegany County will be selected as a demonstration site for sanitary landfill operations. Information will be developed to identify (1) procedures, equipment requirements, and desirable operational techniques for efficient year-round utilization of abandoned strip mines for solid waste disposal; (2) unit costs for disposal; and (3) unit capacity of strip mine landfills.

A second abandoned mine will be selected and used for a sanitary landfill. Investigations at this site will be undertaken to determine any special precautions needed to prevent ground or surface water pollution caused by water leaking through the fill and the effects of the landfill operations on acid production.

All abandoned strip mines in the State suitable for solid waste disposal will be located and their capacity estimated.

PROGRESS TO DATE:

Frostburg site. An abandoned strip mine in Allegany County, was selected as the demonstration site for sanitary landfill operations. The mine is 1,900 ft long, with an average width of 80 ft and an average depth of 42 ft. Before initiation of the project, State Health Department personnel had to spend considerable time in discussing and explaining the project with local citizen organizations and governing bodies in an attempt to show that the project would be an advantage, rather than a detriment, to the area. As a result of this activity, a formal agreement was executed between Frostburg, Allegany County, and the State Department of Health specifying the responsibilities and privileges of each agency in the construction and operation of the landfill and providing for financial support of the project by the city and the county. Other required preliminary activities included securing approval for the landfill operation from the State Department of Water Resources and the State Bureau of Mines; development and institution of a sampling program to determine the effect, if any, of the landfill on adjacent ground waters; acquisition of equipment and operating personnel; site preparation, including removal of standing water, grading, and bottom stabilization, and provision of storm-water diversion ditches.

The landfill was opened to receive refuse on Apr. 1, 1967. Several months after the landfill was opened, a Thurman portable truck scale of 80,000 lb capacity was installed, a data collection and recording system devised, and collection of pertinent data instituted. Information being collected for each vehicle dumping at the site includes vehicle number and type, source and type of refuse, weight of refuse delivered to the landfill, time, date, and weather conditions.

When the landfill was opened, the Allegany County Health Department instituted a campaign to eliminate all haphazard and illegal dumps in the surrounding areas. A concentrated radio, newspaper, and television campaign was undertaken to inform the public that the laws against haphazard dumping would be enforced and that a sanitary landfill had been established in the area. Many of these dumps have been cleaned up, closed, and posted.

Originally, approximately 15,000 people were served by the landfill. During 1968, however, the city of Cumberland closed its open burning dump and began hauling its solid wastes to the Frostburg site, and small dumps in the vicinity of the landfill have been closed, now the site serves about 60,000 people.

During 1968, negotiations between the State and County Health Departments, the city of Cumberland, and the Allegany County Commissioners resulted in an agreement whereby the latter agreed to absorb all costs of solid waste disposal in the county if the municipalities would haul their wastes to approved disposal facilities. The State and County Health Departments also now require that all solid wastes in the county be hauled to existing approved disposal facilities or to new facilities constructed and operated in conformance with State Health Department requirements. As a result, negotiations are underway with large industries to have their solid wastes hauled to an existing approved landfill.

Since there is no refuse collection in many of the rural areas served by the landfill, many individuals haul their own refuse to the facility. This interfered with efficient operation of the landfill and also resulted in an indeterminate quantity of refuse being brought into the site. An intermediate receiving station for such solid wastes was therefore established immediately outside the landfill site. A dump truck was provided into which individuals could deposit their refuse at any time during the day or night, 7 days a week. Since the site was originally closed from 4:30 pm to 8:30 am during the week and all day Sunday, this also provided a disposal facility for persons arriving at the site during these times. At the beginning and end of each working day, the contents of the truck were weighed and placed in the fill. Records were kept of the number of vehicles utilizing this intermediate facility by means of a vehicle trip counter.

Three principal problems developed in connection with this receiving station: (1) The volume of the refuse was more than originally anticipated, and when the capacity of the truck was exceeded on many occasions, there was a pile of refuse around it on Monday morning. (2) The exposed refuse setting for a maximum period of 39 hr (from 4:30 pm on Saturday until 7:30 am on Monday) could result in a rodent problem. (3) In many cases, citizens were dumping refuse around the truck site or somewhere in the general vicinity even when the receptacle was not full.

Evaluation of available records indicated that peak usage hours were between 11:00 am and 5:00 pm on Sunday. A bulldozer operator was put on duty at the site for about 4 hr on Sunday afternoon to empty the dump truck when required and to provide supervision for those using the receiving station. This eliminated all observed problems.

Rough estimates indicate that the costs of disposing of solid waste materials in strip mines are about $1.00 per yr per person served by the facility. This figure was decreased from about $1.40 because of the approximate quadrupling of the number of persons served at the Frostburg site. On the other hand, the cost to the citizens of Cumberland increased by about $1.00 per person per yr because of the increase in haul distances. Detailed analyses on costs per ton and on costs per person bases will be made at the conclusion of the project.

Since the normal operation of the landfill in the strip mine includes cutting away the sides of the mine as it is filled with solid wastes, estimating the unit capacity of the strip mine is difficult until final elevation is reached.

Compaction studies are being considered to determine in-place density of solid wastes placed in the landfill. Computer programs are being developed to illustrate variations in the amounts of solid wastes received. Analyses of water samples collected on a continuing basis since the beginning of the project show no effect on any water supplies in the vicinity of the operation.

Westernport site. The Westernport sanitary landfill, opened for use in September 1968, consists of two abandoned strip mines. In one, experimental domestic refuse cells will be constructed; excess domestic refuse from the contributing towns will be placed in the second. The purpose of the experimental cells is to determine the effects of refuse on acid mine water.

The cells are located adjacent to a stream originating in many upstream abandoned strip mines. A portion of the stream will be diverted through the cells. Analyses will be run on the influent to and the effluent from the cells. The effluent will be treated in a septic tank, passed through a sand filter, and chlorinated before being returned to the stream. These experimental cells are currently under construction.

Evaluation of alternatives in refuse disposal - Raleigh, North Carolina

PROJECT TYPE: STUDY AND INVESTIGATION   **GRANT NO.** D01–UI–00050
GRANTEE: CITY OF RALEIGH
PROJECT DIRECTOR: W. L. BAIRD, DIRECTOR, DEPARTMENT OF PUBLIC WORKS, ROOM 402,
MUNICIPAL BUILDING, RALEIGH, NORTH CAROLINA 27601
ESTIMATED TOTAL PROJECT COST: $147,956
GRANTEE'S SHARE: $ 61,690
FEDERAL SHARE: $ 27,805 [01]
(BY YEAR OF PROJECT LIFE) $ 33,318 [02]
$ 8,719 [03]
DATE PROJECT STARTED: JAN. 1, 1967   **DATE PROJECT ENDS:** DEC. 31, 1969

OBJECTIVES: To demonstrate how a city's solid waste disposal practices may be improved by evaluating alternative disposal methods and salvage possibilities, and applying a mathematical model to the existing collection system to improve its efficiency.

PROCEDURES: Staff of North Carolina State University's Departments of Civil, Industrial and Mechanical Engineering are assisting the city by conducting the technical studies and evaluations.

The simulation model of a refuse collection system developed by Quon, Charnes and Wersan will be applied to the city's refuse collection system to identify cost saving procedures. A sampling program will be conducted to determine the origin, quantity, and composition of the city's solid wastes. The refuse collection system will be analyzed to develop input data for the mathematical model. Several disposal methods will be studied in detail, including sanitary landfill, composting, and incineration, with attention being given to salvage possibilities. Recommendations will be made for a preferred method of disposal.

PROGRESS TO DATE: The following discussion has been summarized from a statement prepared by the grantee.

The Collection System. The Public Works Department is designated as the agency responsible for refuse collection and disposal in the city of Raleigh; however, about 40 percent of the total waste disposed of by the community is collected by private contractors. Refuse is collected thrice weekly from over 36,000 dwelling units. Backyard collections of garbage are made twice a week. On Wednesday, general refuse in containers or tied bundles is picked up at the curb.

The downtown business district is serviced six nights a week by one loadpacker. Another packer operates six days a week to service shopping centers.

Domestic collection services are allocated between 35 different routes. Fifteen routes are serviced by 15 loadpackers carrying one driver and four laborers. The loadpacker routes are in the more densely populated parts of the city and cover between 1,000 and 1,800 services in a two-day period. Twenty routes are covered by two train units. Each unit consists of one "dumpmaster" with a driver, and four or five trains, each consisting of a scout and three carts staffed by two laborers. The train routes are located in less densely populated parts of the city where setbacks are generally in excess of 50 ft. Each train route includes between 500 and 700 services and is covered in one day so that each train covers two routes twice a week.

Commercial refuse collection is largely by box and dumpmaster. The unit purchases a box that is picked up by the city. In the two large shopping centers of Raleigh, 24 and 27 eight cu yd boxes are picked up by the city on a daily basis. The 1966–67 records showed that 600 pickups per week were made of 285 boxes. In 1967–68, 1432 pickups were made each week of 526 boxes. It is possible that in areas where multiple boxes are located, a stationary compactor system may be found feasible.

Only six percent of the 1,136 tons of industrial refuse generated each week is picked up by the city (68.5 tons/week). Approximately 27 percent of the 141 industries in Raleigh have some municipal refuse collection service.

Average cost of collection by the various means provided are shown below:

	$/service	*$/ton*	*$/ton-mile*
Loadpackers	15.44	13.23	0.00193
Dumpmaster and trains	13.43	13.28	0.00221
Dumpmaster and boxes	—	3.00	0.00023

These figures are based on an 8-yr depreciation for loadpackers and dumpmasters, and a 3-yr depreciation on scout and train units. The comparison favors the loadpackers; they are older than 5 yr in all cases, whereas trains are no older than 3 yr in any case. The largest single component of cost for loadpackers is labor. In the train system, the cost of operation and maintenance is nearly equal to the labor cost. In the box system, labor is clearly at a minimum.

A large variation in performance and cost was found for the different collection routes. An examination of each route is being made to determine the causes of such variations, among which could be number of services, service density, and setbacks.

The city of Raleigh disposes of refuse in a sanitary landfill located on State property. The site covers about 18 acres; about 16 acres have been filled since 1959. Since 1939, a total of six different sites have been used. The average use for the past 28 yr has been approximately 3.7 acres/yr, with an average depth of fill of 11 ft. The current landfill is well located adjacent to a major east–west traffic artery; however, it is necessary that a new landfill or alternative method of disposal be soon selected.

In one measurement, an estimated 1,544 tons of refuse was accepted in one 6-day week. Nine hundred tons, or about 60 percent, was collected and delivered by city collection vehicles. An additional 644 tons was collected by institutions such as N. C. State University, the Dorothea Dix Hospital, and private haulers. Current cost of landfill disposal is about $0.47/ton.

When an estimated 13,523 nonresidents and 105,722 residents are considered, the total daily per capita generation of refuse disposed of in the sanitary landfill is 3.7 lb. Since the domestic generation is 2.04 lb/capita/day, the commercial and industrial contribution may be estimated at 1.66 lb/day. These figures do not include wrecking of buildings and automobiles.

Sources and composition of solid waste. Weighing programs conducted at the city's landfill indicated that an average of 1,580 tons of solid wastes per week was received for disposal. Contributions to this total by the several types of sources were estimated from available data and special studies. This breakdown is shown below. There is a remarkably close agreement between the weighed and estimated amounts.

	Tons/week	*% of total*
Domestic	840	53.0
Commercial	676	42.6
Industrial	69	4.4
Total	1,585	100.0

The physical composition of the refuse was estimated from very detailed analyses of domestic refuse and certain national studies and is shown below.

Category	*Tons/week*	*% by weight*
Combustibles	1,224	78.9
Garbage	191	12.3
Paper	875	56.4
Other (brush and clippings)	158	10.2
Noncombustibles	329	21.1
Metals	106	6.8
Glass	120	7.7
Other	103	6.6

The large amount of paper and the small amount of garbage are large departures from studies made in the 1930 and 1940 decades, when ashes and garbage were significant fractions of the total refuse.

Very detailed chemical analyses were performed on the domestic waste for the purpose of determining the potential for composting the refuse. Only a few of the results, however, are reported here.

Analysis	*Food wastes*	*Other combustibles*
Moisture (wet weight)	69.25%	19.6%
C/N ratio (dry weight)	15.4	175
Calorific value (dry weight)	7,300 Btu/lb	7,820 Btu/lb
(wet weight)	4,400 Btu/lb	4,400 Btu/lb

The collection model. A simulation model for the collection system was adapted to the Raleigh loadpacker system. The object here was to determine points of attack in improving collection. The model could be varied in a number of essentials to predict effects of changing the load carried per vehicle trip to the landfill, the number of collections per week, the number of pickup men, and the use of curb collection.

The model was first verified with data from the present collection system, then the factors were varied.

Among the findings of these studies were: (1) Loads carried per trip to the landfill were light compared to loads quoted by equipment manufacturers. Even small increases from 340 lb per cu yd to 500 lb per cu yd should effect savings by reducing the number of trips to the landfill. (2) Two collections per week would be as effective as three collections a week. One collection per week would result in substantial savings. (3) Curb collections would require only half as much labor as the present backyard collections. (4) Landfills close to the city offer obvious savings in haul costs. It is intended that each of these conclusions be tested in demonstrations on some routes in the city during 1969.

Studies of Disposal Alternatives. Landfill proved to be the least costly method of refuse disposal for the next 10 yr, even in the event that Raleigh had to purchase land. A number of potential landfill sites was examined, and a land acquisition program was recommended. Since there is a large amount of state-owned land in the Raleigh area, it is possible that in some cases at least the trade off of free collection service for the use of land is feasible.

Other studies included:

1. Welfare salvage that serves a useful, but somewhat limited, function in Raleigh. The amount of salvage in the categories of garments, furniture, paper, and scrap iron totals about 14 tons per week.

2. Wood scrap is used as fuel.

3. Rags are a possible source of salvage only if some other item is recovered; that is, it could not pay the cost of recovery on its own.

4. Metal scrap is almost completely salvaged.

5. Metal from tin cans is not a promising venture since the current markets are far removed from Raleigh.

6. Glass recovery does not appear practical because of problems of quality control and the very low cost of raw materials in the glass industry.

7. Rubber recovery is not feasible because of remoteness of markets.

8. Plastics are not at present an economically reclaimable material. Some of the urea form plastics find their way to the fertilizer.

9. Paper is a feasible item for recovery, but would require a large capital investment for separation. For most advantageous resale, a pulping and deinking operation should be included in any plans. The study does not recommend consideration of recovery at the present time. Few cities are equipped with the staff for promotion and sale of a product.

10. Composting of refuse with sewage sludge could be accomplished if a market could be developed. In that event, the combined recovery of paper and composting of refuse and sludge could be an economical means for disposal of two community waste products.

11. Incineration is a relatively expensive means of refuse disposal. The heat value of Raleigh refuse is equivalent to about 60 tons of coal per day. The capital costs and operating expenses, however, place the disposal of refuse by simple incineration at about $4.70 per ton in Raleigh, or about 10 times the cost of landfill.

Countywide sanitary landfill refuse disposal project

PROJECT TYPE: STUDY AND INVESTIGATION GRANT NO D01–UI–00053
GRANTEE: BROOME COUNTY BOARD OF SUPERVISORS, COUNTY OFFICE BUILDING
PROJECT DIRECTOR: ROLAND M. AUSTIN, DIRECTOR, ENVIRONMENTAL HEALTH SERVICES, BROOME COUNTY HEALTH DEPARTMENT, 62 WATER STREET, BINGHAMTON, NEW YORK 13901
ESTIMATED TOTAL PROJECT COST: $42,000
GRANTEE'S SHARE: $14,000
FEDERAL SHARE: $28,000 [01]
(BY YEAR OF PROJECT LIFE)
DATE PROJECT STARTED: NOV. 1, 1966 DATE PROJECT ENDED: DEC. 31, 1967

OBJECTIVES: To demonstrate how new or improved solid waste management techniques could solve a regional solid waste problem by conducting a study that will enable the Broome County Board of Supervisors to select the solid waste disposal system that will best meet the needs of the county.

PROCEDURES, FINDINGS, AND RECOMMENDATIONS: The study was conducted by William J. Virgilio, Consulting Engineer, Endicott, New York, and has been completed. Principal conclusions and recommendations are summarized below:

The present population of Broome County (222,000) produces an estimated 183,000 tons of refuse per year. Projected population by the year 2000 is 354,000 people with a refuse production of 446,000 tons per year. Broome County is an L shaped area, with the major part of its population concentrated at the junction of the two legs, in the city of Binghamton and environs. Of the total amount of refuse produced in the county, 85 percent is generated in the Binghamton area.

The recommended solid waste disposal system consists of three landfills; the largest to be established in the Binghamton area, with smaller landfills near the end of each of the legs of the county. The county should construct and operate these landfills with financing provided by a tax levied for this purpose. The Broome County Health Department should be the regulatory agency in charge of the refuse disposal system. Refuse collection should remain the responsibility of the individual municipalities.

The county has conducted a public information program to acquaint the public with the recommended disposal plan and the need for, and benefits of, a countywide system.

Refuse crusher

PROJECT TYPE: DEMONSTRATION GRANT NO. D01–UI–00057
GRANTEE: CITY OF TACOMA, WASHINGTON
PROJECT DIRECTOR: GILBERT M. SCHUSTER, DIRECTOR, PUBLIC WORKS DEPARTMENT,
CITY OF TACOMA, COUNTY-CITY BUILDING, TACOMA, WASHINGTON 98402

ESTIMATED TOTAL PROJECT COST:	$419,717
GRANTEE'S SHARE:	$139,906
FEDERAL SHARE:	$105,358 [01]
(BY YEAR OF PROJECT LIFE)	$114,067 [02]
	$ 60,386 [03]

DATE PROJECT STARTED: JUNE 1, 1967 DATE PROJECT ENDS: MAY 31, 1970

OBJECTIVES: To demonstrate improved disposal of demolition wastes by incorporating them into a sanitary landfill after crushing.

PROCEDURES: The entire project will be conducted by city personnel. A mechanical crusher or shredder, scales, and a scale house will be purchased and installed at the existing landfill site. A metal-wheeled compactor will also be purchased.

The project will be conducted in three phases, each lasting approximately 6 mo.

Phase I. The sanitary landfill will operate under controlled conditions without use of demolition material. (Demolition wastes are not now accepted at the landfill.)

Phase II. The sanitary landfill will be operated under controlled conditions with unshredded demolition waste incorporated with the regular municipal refuse.

Phase III. The sanitary landfill will be operated under controlled conditions with shredded demolition waste incorporated with the regular municipal refuse.

During all phases of the project, records of weights and volumes of solid wastes received and incorporated into the sanitary landfill will be maintained. Savings in landfill volume that result from shredding the demolition wastes and economics of the process will be determined. Evaluation of the feasibility and practicality of the procedures employed will be made by the Department of Public Works.

Feasibility and advantages of shredding other types of solid wastes before incorporation into the landfill will also be explored.

PROGRESS TO DATE: The first 6 months of this project were devoted to preliminary planning. After considering various types of steel-wheeled compactors, the city purchased the Rex-Trashmaster. This equipment was delivered to the site late in December 1967.

The first bids for construction of a scale house and installation of scales at the site failed to meet the specifications and were rejected. New bids were called for in April 1968, and a construction contract was awarded on May 14. Construction was completed, and the city accepted the facility in October, 1968.

To implement Phase I of the project, an area at the sanitary landfill was cross-sectioned so that the weight-volume relationship of the disposed solid wastes can be developed. Part of the demonstration area lies over an existing fill. Plywood sheets have been laid over the old fill, their location referenced, and elevations recorded for the purpose of determining settlement as the project progresses. Various crushers are being investigated to select one that will be adequate for Phase III of the project. A portable crusher, which appears to have much merit, was demonstrated on the landfill site in December

1968. Operating difficulties, however, required that the machine be returned to the factory for adjustment and repair. This equipment will be demonstrated further during 1969. A schedule is being prepared for demonstrations of other types of crushers.

Des Moines metropolitan area solid waste study and investigation

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PROJECT TYPE: STUDY AND INVESTIGATION **GRANT NO.** D01–UI–00060
GRANTEE: CITY OF DES MOINES, IOWA
PROJECT DIRECTOR: LEO L. JOHNSON, DIRECTOR OF PUBLIC SERVICES, CITY HALL,
DES MOINES, IOWA 50309
ESTIMATED TOTAL PROJECT COST: $109,483
GRANTEE'S SHARE: $ 36,494
FEDERAL SHARE: $ 72,989 [01]
(BY YEAR OF PROJECT LIFE)
DATE PROJECT STARTED: APR. 1, 1967 **DATE PROJECT ENDED:** NOV. 31, 1968

OBJECTIVES: To demonstrate how new or improved solid waste management techniques could solve a regional solid waste problem by making a comprehensive and detailed analysis of present solid waste collection and disposal operations in the Des Moines metropolitan area and by developing recommendations for the best regional system for solid waste collection and disposal.

PROCEDURES, FINDINGS, AND RECOMMENDATIONS: The consulting engineering firms of Henningson, Durham & Richardson, Inc., Omaha, Nebraska, and Veenstra and Kimm, West Des Moines, Iowa, conducted the study.

Major conclusions and recommendations were:

The population of the study area, presently estimated at 288,000, is expected to reach 361,000 by 1980 and 418,000 by 1990. The total amount of all solid waste presently being disposed of in the study area is approximately 1,016,000 cu yd per yr (after compacting) or 562,000 tons per yr. This includes waste disposed of at the 10 dump and landfill sites in the study area and that disposed of onsite by private individuals, business, and industry. These annual waste quantities, for which proper disposal facilities must be provided, will reach an estimated 1,500,000 cu yd or 783,000 tons by 1990.

An area-wide public collection system is recommended to replace the various municipal, contract, and private systems now being operated. This system would provide weekly collection of all domestic waste from the dwelling units within the study area, which is a change from the present practice of collecting only garbage or kitchen waste. No public collection service would be offered to large multiple family dwellings, commercial, or industrial waste producers.

Private refuse haulers should be licensed and regulated. They would continue to serve that part of the community not receiving public collection service.

The new collection system includes combining the existing manpower and equipment of the Des Moines, West Des Moines, and Urbandale collection systems into a single, efficient area-wide collection system. New routes, standards, work rules, and administrative and technical procedures have been developed to implement the program.

The cost to provide total collection service to each dwelling unit in the study area is estimated to be $0.90 per mo or $10.80 per yr. This cost, which is less than the present costs for collecting kitchen waste only, also includes disposal costs of the collected refuse.

The sanitary landfill method of waste disposal is recommended as being the most economical, practical, and efficient method for the study area. Two sanitary landfill site locations are proposed, of sufficient size, to dispose of the estimated study area waste for the 20 yr from 1968 through 1987.

A fee system is proposed for the use of the sanitary landfill sites that will produce sufficient revenue to make the disposal operations entirely self-supporting and to amortize the initial cost of equipment, land, and improvements.

Interim improvements and a temporary fee system are proposed for the existing Des Moines landfill sites. These improvements contemplate converting these sites to model sanitary landfills as a public relations aid to the establishment of the permanent new sites.

A Metropolitan Solid Waste Agency that will be responsible for the collection and disposal of all solid waste produced within the study area is recommended. This agency would be governed by a board composed of certain elected representatives of the 14 cities, towns, and counties in the study area.

The agency will provide collection services to all member municipalities on a contract basis of approximately $10.80 per yr per dwelling unit. The agency will also operate the two sanitary landfill sites, open to anyone wishing to dispose of solid waste, for a fee of approximately $1.10 per ton.

The initial capital expenditures of the agency will be financed by a revenue bond issue. Sufficient revenues are anticipated from the fees proposed for the collection and disposal operations to retire the bonds as well as provide the necessary maintenance, operating, and administrative costs of the agency.

Uniform waste collection and disposal ordinances to be adopted by all agency member communities are recommended. Model ordinances have been prepared and included in the report.

PUBLICATION:

Henningson, Durham & Richardson, Inc. Collection and disposal of solid waste for the Des Moines metropolitan area; a systems engineering approach to the overall problem of solid waste management; an interim report. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. [324 p.]

Investigate and evaluate feasibility of refuse baling as a means of conserving sanitary fill space

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PROJECT TYPE: STUDY AND INVESTIGATION **GRANT NO.** D01–UI–00061
GRANTEE: PUBLIC WORKS DEPARTMENT, CITY OF SAN DIEGO
PROJECT DIRECTOR: ERIC QUARTLY, PUBLIC WORKS DIRECTOR, CITY OF SAN DIEGO,
CITY ADMINISTRATION BUILDING, SAN DIEGO, CALIFORNIA 92101

ESTIMATED TOTAL PROJECT COST:	$90,900
GRANTEE'S SHARE:	$30,300
FEDERAL SHARE: (BY YEAR OF PROJECT LIFE)	$60,600 [01]

DATE PROJECT STARTED: JUNE 1, 1967 **DATE PROJECT ENDED:** MAY 31, 1968

OBJECTIVES: To investigate the feasibility of improving current solid waste disposal methods by analyzing refuse baling and comparing it with present sanitary landfill conservation methods to determine the relative efficiency and economics of refuse baling as a means of extending the life of sanitary landfill sites and of reducing the haul distance of refuse collection vehicles.

PROCEDURES, FINDINGS, AND RECOMMENDATIONS: The project was conducted by the technical staff of the city. A final report has been prepared; the major findings and recommendations are summarized below:

At the present time, San Diego is generating more than a half million tons of refuse a year, or about 4⅓ lb per person per day. Rapid population growth and gardual increases in the per capita generation of refuse are expected to double this tonnage by 1985. Although this growing demand will, in itself, result in higher current expenditures for sanitation service, its impact will be compounded by the exhaustion of existing favorably located landfills, the necessity for acquiring new, more remote locations, and accelerated increases in costs that result from longer direct hauls by collection vehicles.

As part of the evaluation of the feasibility of refuse baling as a means of conserving sanitary landfill space, the compaction now being obtained by conventional landfill methods was compared with that potentially obtainable by baling. A field survey of conventional compaction was made at a city landfill to determine the weight and compacted volume of refuse now being deposited; to investigate baling, refuse was actually baled in controlled test situations.

Normally, the tonnage of refuse brought to the landfill by private citizens and commercial contractors is not weighed. In the field survey, however, this tonnage was determined by counting and classifying all private vehicles entering the landfill during a 14-wk test period, weighing a 23-percent sample during the first 6-wk phase of the test, and developing average weight factors for each vehicle classification. These estimates of private tonnage were added to the actual recorded tonnage brought in by city collection trucks, and the combined tonnage was compared with the compacted volume of the materials as determined by aerial volumetric surveys. In three separate phases, the study examined differences in densities obtained with the use of different types of compacting equipment and with varying amounts of water added manually to the refuse during compaction.

Compaction ranged between 1,189 and 1,383 lb to the cu yd, better results were obtained with a compactor than with a bulldozer, and the application of larger amounts of water to the refuse improved effectiveness.

The feasibility of baling refuse and the degree of compaction obtainable by this method were investigated at two levels: (1) an extended local test was conducted in which unprocessed refuse was baled in a leased, light-duty baler installed at a test facility especially constructed for this purpose, and (2) an interested baler manufacturer, using modern, heavy-duty equipment, demonstrated refuse baling.

In the local baling test, a total of 48.5 tons of typical city-collected refuse was processed during a 5-wk period into 162 bales averaging 599 lb apiece in weight and 689 lb to the cubic yard in density. The composition of the bales was classified, and such characteristics as shape, handling ease, odor absence, fines retention, and liquid retention were rated. As a second phase of this program, 64 additional bales were produced and "nested" in a simulated landfill situation.

On Jan. 9, 1968, at its plant in Bellevue, Ohio, the American Baler Company conducted a demonstration of baling preshredded municipal refuse. The four complete bales that were produced ranged from 1,500 to 2,490 lb in weight, from 0.92 to 1.56 cu yd in volume, and from 1,466 to 1,593 lb to the cubic yard in density. On the basis of this experience and its background of previous knowledge in the field, the company believes that densities close to 1,900 lb to the cubic yard are practicable. Bale densities of this magnitude probably approach the maximum obtainable without resorting to relatively slow, cumbersome, and expensive multiple-stage baling presses.

Findings in both the local test and the factory demonstration tended to supplement and reinforce each other. The balers used in both tests were of the same basic horizontal design, which lends itself to more continuous, higher production than other types. Locally, it was shown that ordinary city-collected refuse can be successfully processed, even without preshredding, into reasonably well-formed bales that generally maintain their integrity during transportation and disposal. Since the local test involved a larger quantity of materials (an estimated 65 tons in all as compared with perhaps 5 or 6 tons at Bellevue) and extended over a period of time, it established the feasibility of baling refuse that varies considerably in composition and moisture content from day to day and from one collection area to another. The Bellevue test provided persuasive evidence of the desirability of shredding the refuse before it is fed into the baler and of utilizing baling equipment of high-compression capability. The factory-produced bales were not only denser but better shaped, with sharp, well-defined corners and relatively smooth surfaces, and they maintained their integrity without appreciable distortion during handling.

Densities obtained locally are not competitive with the approximately 1,380 lb to the cubic yard obtainable by efficient landfill methods, but the compaction obtained at the factory exceeds that level. Based on the compaction actually reached in that test (1,593 lb to the cubic yard) and allowing 5 percent of volume for voids between bales in place in a landfill, the space required per ton for refuse in bales would be 91 percent of that required with our best present landfill methods. If the greater density (1,890 lb to the cubic yard) predicted by the company were reached and the same allowance for voids made, the space required per ton would be 77 percent of that required with conventional methods. Thus, the potential saving in landfill life that is realizable by baling can be expected to fall between 9 and 23 percent.

The potential economic benefits of baling refuse can be fully realized, however, only in the operational setting of a transfer station. The project staff made preliminary studies of the economic feasibility of a full-scale baling transfer station where because of the exhaustion of an existing favorably located landfill, longer direct haul to a more remote landfill by collection vehicles would be required. They concluded that under the San Diego conditions studied, when the additional round-trip distance required per truck by longer direct haul exceeds about 10.1 miles, the baling transfer station would be more economical than direct hauling. In the station capacity ranges studied (300 to 350 tons a day), a net savings also can be realized by baling despite the baling operating costs because of the reduction in the cost of land for the station site, in rehaul equipment, and in compaction equipment and labor at the landfill. This would make a baling transfer station (fully equipped with balers, a hogger, and conveyors) more economical than a conventional station in which refuse is simply transferred from collection to rehaul vehicles. This conclusion might not be valid, however, if the comparison were made with a conventional transfer station of larger capacity and consequently greater efficiency.

A pilot baling transfer station is needed (1) to test these tentative conclusions under actual production conditions, (2) to refine baling techniques and routines, (3) to ascertain the optimum moisture content of the refuse being baled, (4) to compare the compaction obtainable with preshredded versus unprocessed refuse, (5) to determine and deal with any possible nuisance factors or health hazards (such as noise, dust, odor, and vector breeding) that may be encountered in the operation, (6) to develop effective practices in placing the bales in a landfill, (7) to explore the feasibility of other means of bale disposal, such as in the reclamation of small canyons near residential areas, and (8) to develop accurate cost comparisons. To implement and prove out the combined baling and transfer concepts, a pilot baling transfer station would, in the long view, be a potentially rewarding investment.

Development of master plan for solid waste collection and disposal

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PROJECT TYPE: STUDY AND INVESTIGATION **GRANT NO.** D01–UI–00063
GRANTEE: CITY OF NEW ORLEANS
PROJECT DIRECTOR: F. EARL BERRY, SUPERINTENDENT OF SANITATION, ROOM 2W13, CITY HALL,
NEW ORLEANS, LOUISIANA 70112

ESTIMATED TOTAL PROJECT COST:	$117,913
GRANTEE'S SHARE:	$ 39,304
FEDERAL SHARE:	$ 78,609 [01]
(BY YEAR OF PROJECT LIFE)	

DATE PROJECT STARTED: JUNE 1, 1967 **DATE PROJECT ENDED:** MAY 31, 1968

OBJECTIVES: To demonstrate how new and improved solid waste management techniques could solve a regional solid waste problem by analyzing existing solid waste collection and disposal facilities in the New Orleans metropolitan area, and developing a master plan for an integrated collection and disposal system.

PROCEDURES, FINDINGS, AND RECOMMENDATIONS: The firms of Albert Switzer & Associates, Inc., Baton Rouge, Louisiana, and Greenleaf/Telesca Engineers, Miami, Florida, provided consulting engineering services. The study consisted of three phases.

Phase 1. Population and economic studies. This included estimates of present and future population to the year 1986, and population densities; studies of present and estimated future economic and industrial development, existing and proposed land use, and analysis of other pertinent factors of economic growth in the area.

Phase 2. Master waste collection and disposal plan. This included studies of existing collection and disposal systems, estimation of quantities and characteristics of solid wastes generated, and estimates of future solid waste production. Costs of operating existing facilities were obtained. A proposed regional collection and disposal system to serve the area for the next 20 yr was recommended.

Phase 3. Economic and financial studies. Comparative costs of constructing and operating the various facilities studied were developed. Net revenues available for financing the recommended project were estimated, as well as additional revenues needed. A proposed rate structure was developed.

The study area included the parishes of Orleans, Jefferson, and St. Bernard, generally covering the New Orleans metropolitan area, and was limited to the developed and populated portions of those parishes. A separate study of the West Bank area of Jefferson Parish (see summary for Grant No. D01–UI–00019) was coordinated with this project.

Present population of the study area is estimated as 1,073,000, and is expected to increase to 1,131,000 by 1970; 1,489,000 by 1980; and 1,966,000 by 1990, or an increase of nearly 100 percent in the next 22 yr. At the same time, the per capita rate of refuse production is expected to increase by 15 percent per decade. It is estimated that 2,280 tons per day of combustible refuse are currently generated within the area. It is anticipated that this quantity will increase to 3,675 tons per day by 1980 and to 5,700 tons per day by 1990.

The consultant's conclusions and recommendations, which apply to the Tri-Parish area as a whole, or where inter-parish cooperation is considered, are summarized below. Additional conclusions and recommendations specific to each individual parish are also presented in the consultant's final report but are not reproduced here.

CONCLUSIONS: Existing landfills, municipal as well as private, are not operated in accordance with accepted health standards owing principally to: (1) filling in areas where leachates can contaminate streams and bayous, (2) lack of suitable cover material in the area, and (3) the practice of burning refuse at the site.

Existing landfills should be converted to sanitary landfills by diking, draining, and providing adequate and suitable cover material so as to stop air and water pollution and eliminate possible health hazards.

To immediately prohibit further open dumping or burning of combustible materials, sanitary landfills should be established and operated for the disposal of all putrescible and combustible refuse in excess of the capabilities of the incinerators until such time as sufficient incinerator capacity can be provided.

Enforcement of regulations concerning collection and disposal of solid waste is lax owing largely to insufficient funding and manpower assigned for this purpose.

The need for diking and draining the site, for purchasing suitable cover material, and for limiting the depth of fill each adds to the cost of sanitary landfill operation in the area, making this method of disposal less competitive than is frequently the case.

When based upon a study of methods considered for the area, incineration was found to be the most practical and economical method of satisfactory refuse disposal to meet both present and future needs.

An incineration program to cover the requirements of the Tri-Parish area for the next 20 yr will increase considerably the reliability of the entire waste collection and disposal system.

Cooperation in the joint usage facilities between the parishes in the Tri-Parish area will result in a more effective and economical refuse disposal system, and could save as much as 10 to 15 percent in overall disposal costs.

The communities should formulate and adopt common standards, preferably under the administration of a single authority, for the control and regulation of the disposal of waste. These standards, in the form of a master ordinance, should incorporate by reference the recommended specifications for disposal of all types of solid wastes by methods that are acceptable to local, State, and Federal authorities.

This authority should establish policy, administer control, and enforce the adopted regulations. Such regulations should specifically prohibit open dumping and open burning of all wastes that would present environmental hazards or any means of disposal that would contribute undesirable pollution levels to the air, water, or land.

Control of all refuse disposal facilities under a single authority would provide the maximum reliability and flexibility of operation at the lowest possible operating cost. This would probably result in an annual savings of 5 to 10 percent.

Orleans and St. Bernard Parishes should consider the use of a joint disposal facility before 1980 to handle refuse in excess of the capacities of the enlarged Florida Avenue and the New St. Bernard Incinerators.

Orleans and Jefferson Parishes and the city of Gretna should consider the joint use of the Algiers Incinerator for the disposal of refuse generated in the area.

Combustible refuse production in the area will amount to 3,675 tons/day in 1980 and is expected to reach 5,700 by 1990.

The proposed disposal program by incineration will require an estimated capital investment of $19,100,000 by 1980; and an additional capital investment of $17,100,000 in the continuing period to 1990, based on 1967 costs.

An effective annual incineration capacity of 1,400,000 tons will be available under the proposed program by 1980 and will be expanded to slightly over a 1,800,000 ton capacity by 1990.

Operating at full effective capacity, estimated annual costs of these incinerator facilities are expected to be about $4,500,000 by 1980, and $6,400,000 by 1990, based on 1967 costs.

RECOMMENDATIONS: Convert present landfills receiving putrescible and combustible refuse to sanitary landfills by diking, draining, and adequately covering the refuse daily with suitable material and adopt ordinances to regulate these operations.

Unconverted landfills should receive only noncombustible refuse that will not contaminate waters leaching or draining from the fill.

Prohibit further open dumping or burning.

Enforce regulations concerning collection and disposal of solid wastes and assign sufficient personnel for this purpose.

Dispose of all combustible waste generated in the area by incineration in modern incinerators with adequate air pollution control.

Adopt air pollution control limits conforming to the Los Angeles County requirements.

Select incinerator service areas that will produce at least 600 tons of refuse per day within a reasonable period to ensure minimum disposal costs through economical incinerator operation and haul costs.

Undertake, through an agency such as the Regional Planning Commission, to sponsor an authority which will formulate standards and encourage adoption and implementation of such standards by each community as rapidly as possible with an agreement upon deadline for compliance by not later than 1980.

Arrangements be made by Orleans and St. Bernard for the joint disposal of refuse in excess of the capacities of the enlarged Florida Avenue and St. Bernard Incinerators.

Arrangements be made by Orleans and Jefferson Parishes and the city of Gretna for the joint dispoasl of refuse generated in the area at the Algiers Incinerator.

PUBLICATION:

Albert Switzer & Associates, Inc. and Greenleaf/Telesca. Master plan for solid waste collection and disposal tri-parish metropolitan area of New Orleans; final report on a solid waste management demonstration. Public Health Service Publication No. 1932. Washington, U.S. Government Printing Office, 1969. [359 p.]

Solid waste disposal study for Oakland County, Michigan, and adjacent communities

PROJECT TYPE: STUDY AND INVESTIGATION GRANT NO. D01–UI–00068
GRANTEE: OAKLAND COUNTY BOARD OF SUPERVISORS, 1200 NORTH TELEGRAPH ROAD,
PONTIAC, MICHIGAN 48053
PROJECT DIRECTOR: DANIEL W. BARRY, AGENT, COUNTY DRAIN COMMISSIONER,
550 SOUTH TELEGRAPH ROAD, PONTIAC, MICHIGAN 48053
ESTIMATED TOTAL PROJECT COST: $124,500
GRANTEE'S SHARE: $ 41,500
FEDERAL SHARE: $ 83,000 [01]
(BY YEAR OF PROJECT LIFE)
DATE PROJECT STARTED: AUG. 1, 1967 DATE PROJECT ENDED: JULY 31, 1968

OBJECTIVES: To demonstrate how new or improved solid waste management techniques could solve a regional solid waste problem by formulating a system of solid waste disposal for Oakland County that will facilitate the implementation of the regional solid waste disposal plan as established by the Detroit Metropolitan Area Regional Planning Commission.

PROCEDURES, FINDINGS, AND RECOMMENDATIONS: The study was conducted by the consulting engineering firm of Jones and Henry, Toledo, Ohio. Information was collected concerning the sources, amounts, and characteristics of solid wastes generated in the study area, and estimates made of amounts expected to be generated from 1970 to 1990. Present collection practices and disposal sites and methods were identified. Also explored were such matters as secondary transportation, rural problems, and legal, financial, and public relations aspects of the problem. A brief investigation was made of the desirability of cooperative endeavors with adjacent Wayne and Macomb Counties.

Information from many sources was compiled and evaluated. Data were gathered from questionnaires, by telephone, and by personal interview. Aerial photographs, previous reports, on-site visits to disposal operations, and interviews with operating and supervisory personnel provided much of the information upon which the consultant's recommendations were based. Various mathematical analyses were carried out by computers, allowing a more thorough study of alternatives than would otherwise have been possible.

Estimated quantities of incinerable solid wastes generated in Oakland County are as follows:

Year	*lb/capita/day* *Residential*	*Commercial**	*Industrial**	*Total*
1970	2.78	0.97	1.46	5.21
1975	3.06	1.23	1.48	5.77
1980	3.23	1.28	1.33	5.84
1985	3.35	1.45	1.31	6.11
1990	3.43	1.45	1.23	6.11

* Does not include solid wastes which cannot be incinerated.

Three methods of organized solid waste collection services now exist in the county: (1) Municipal collection, provided in six cities, in which the municipality collects solid waste with its own personnel and equipment. (2) Contract collection, provided in 26 municipalities, in which the municipality contracts with a private individual or firm who then provides the personnel and equipment for solid waste collection. (3) Private collection, provided in 20 governmental units, in which solid waste collection services are provided by a private individual or firm by direct arrangement with the individual householder.

A variety of disposal methods were found to be employed in the county. These included open dumping, sanitary landfill, and incineration, used to varying degrees by governmental units, private collectors, industries, and individuals. Many of the disposal sites used by municipalities and townships were operated privately by contract collectors or private haulers. Open burning is practiced throughout the county. Individual trash burners or barrels were found to exist almost without exception at rural and suburban homes, and refuse was burned on the site by many commercial establishments in rural areas.

Two plans were developed for a countywide system for the disposal of solid wastes:

1. Plan A, adoption of which is recommended by the consultant, encompasses all of Oakland County, including provision of supplementary service for the Southeastern Oakland County Incinerator Authority, which is now and would remain an independent disposal authority. Under this plan, all combustible refuse will be delivered to incinerators located throughout the county. Delivery of refuse to the incinerators will be facilitated through secondary transport systems. This plan involves a phased program of incinerator construction and transfer station establishment. Rural areas will be aided in refuse handling by establishing "convenience centers" at a number of locations. These would contain portable sanitary containers in which refuse could be deposited and would primarily be for the use of individuals and commercial establishments who haul their own waste, although one or two could be constructed large enough to permit private haulers to use them as a transfer station. The portable containers would be emptied daily and their contents taken to a disposal site. Under this cooperative plan, the county would construct and maintain all facilities outside of the authority. In return, the county would sell its capacity at a specified rate per ton and would complete the disposal of refuse brought to it by authority members. The authority could reduce the charges of the county by permitting it to use an authority-owned ash-disposal facility. As an alternative, residue from the incinerator plants would be taken to an ash-disposal site in Addison Township. A cooperative operation between the county and the authority should benefit both.

2. Plan B sets forth a program that will include all members of the Oakland County community who are not members of the Southeastern Oakland County Incinerator Authority. All combustible refuse originating outside of the authority's area would be delivered to incinerators located throughout the county. A secondary transport system similar to that of Plan A would be used. Rural areas would be served by a convenience center program.

For both plans, acquisition of sufficient land on which to dispose of noncombustible materials is proposed. This includes construction and demolition debris, foundry sand, fly ash, trees, trimmings and brush, and industrial sludges and liquids. The consultant recommends the continued disposal of the latter by private firms who have the equipment and knowledge to properly handle this material. As an alternative to land disposal of trees, trimmings, and brush, a special burner might be considered.

PUBLICATION:

Jones & Henry Engineers Limited. Proposals for a refuse disposal system in Oakland County, Michigan: final report on a solid waste demonstration grant project. Public Health Service Publication No. 1960. Washington, U.S. Government Printing Office, 1970. (In press.)

Farmington River Valley solid waste disposal study and investigation

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PROJECT TYPE: STUDY AND INVESTIGATION **GRANT NO.** D01–UI–00069
GRANTEE: TOWN OF FARMINGTON
PROJECT DIRECTOR: STEPHEN A. FLIS, TOWN MANAGER, TOWN OF FARMINGTON, TOWN HALL,
UNIONVILLE, CONNECTICUT 06085
ESTIMATED TOTAL PROJECT COST: $55,875
GRANTEE'S SHARE: $18,625
FEDERAL SHARE: $17,150 [01]
(BY YEAR OF PROJECT LIFE) $20,120 [02]
DATE PROJECT STARTED: APR. 1, 1967 **DATE PROJECT ENDS:** MAR. 31, 1969

OBJECTIVES: To demonstrate how new and improved solid waste management techniques could solve a regional problem by conducting a study to determine how, and to what extent, a group of towns can provide their householders with a better refuse collection and disposal service at feasible cost through community or group action, as differentiated from each town acting separately.

PROCEDURES: The towns of Farmington, Avon, Canton, Plainville, and Simsbury will work together to secure all facts required to meet the objectives of the study. Consulting engineering services will be provided by the firm of Camp, Dresser and McKee, Boston, Massachusetts.

The project will be carried out in accordance with the following procedural outline: (1) estimate refuse collection and transportation costs for different methods and collection frequencies, while providing uniform and better service to the homeowner; (2) determine the location, size, and availability of refuse disposal sites that will best serve this group of towns, and possibly contiguous municipalities, if economic considerations so indicate; (3) determine the types and cost of refuse disposal facilities that will most efficiently serve these towns; (4) evaluate the possibility of employing several disposal methods in the proposed system; (5) develop a training program for personnel operating solid waste services; (6) establish and recommend for adoption uniform refuse handling and storage procedures at the household level; and (7) establish procedures for the disposal of tree trimmings, logs, stumps, and bulky objects, including junked cars.

PROGRESS TO DATE: Facts relating to existing collection and disposal services and costs have been compiled for each of the five towns. The quantity and characteristics of all refuse now being handled have been estimated by field surveys made during May and August, 1967. Information concerning industrial solid waste production and disposal methods was obtained by an industrial questionnaire. These data have been summarized, and estimates of future solid waste generation have been prepared. Information concerning junked cars has been obtained from several of the towns.

Existing disposal areas and practices have been examined and evaluated. Population densities and major road networks in the five-town region have been delineated. Investigations of possible sites for a joint disposal facility have been completed. The engineer's recommendations as to the best approach to solid wastes management for the five-town region have been prepared. These recommendations indicate that a regional approach for solid waste collection and disposal would be the most beneficial for the towns. Similar bylaws for onsite storage and collection of refuse should be adopted by the five towns. A regional sanitary landfill should be initiated by the towns and developed as a recreational area for picnicking, hiking, bicycling, etc.

Discussions have been held with the public officials of the involved towns concerning the engineer's recommendations, and work is now underway to create a governmental unit that will implement these recommendations.

Solid waste disposal study for Flint and Genesee County metropolitan area, Michigan

PROJECT TYPE: STUDY AND INVESTIGATION GRANT NO. D01-UI-00070
GRANTEE: GENESEE COUNTY
PROJECT DIRECTOR: THOMAS H. HAGA, DIRECTOR—COORDINATOR, GENESEE COUNTY METROPOLITAN PLANNING COMMISSION, 511 COURTHOUSE, FLINT, MICHIGAN 48502
ESTIMATED TOTAL PROJECT COST: $61,496
GRANTEE'S SHARE: $20,499
FEDERAL SHARE: $40,327 [01]
(BY YEAR OF PROJECT LIFE) $ 670 [02]
DATE PROJECT STARTED: AUG. 1, 1967 **DATE PROJECT ENDED:** JULY 31, 1968

OBJECTIVES: To demonstrate how new or improved solid waste management techniques could solve a regional solid waste disposal problem by developing a regional plan for Genesee County and the Flint metropolitan area.

PROCEDURES, FINDINGS, AND RECOMMENDATIONS: The study was conducted by the consulting engineering firm of Consoer, Townsend and Associates in Michigan. All previous relevant studies of the region were reviewed. Surveys were made of all existing solid waste collection systems; and all existing disposal sites were visited, except in a few cases where permission to make such a visit was withheld. A search was made for possible new disposal sites, and those that were found were evaluated for ease of access, availability of necessary utilities, accessibility to adequate road networks, and safety from possible water contamination. Estimates were made of the amounts and types of solid wastes currently generated in the study area. These estimates were based on records of the city of Flint, replies to questionnaires, sampling surveys, and a very complete survey by the Manufacturers Association of Flint of all industrial solid wastes generated by the major industries. A preliminary plan was developed for a solid waste management system to effectively deal with all solid wastes generated in the county.

A summary of the consultant's principal findings and recommendations from his final report on the project follows.

Based upon the best available information, it is estimated that at the present time solid waste is being generated within the county in the following quantities:

Domestic or residential refuse	83,038	tons/yr
Commercial and institutional refuse	38,197	tons/yr
Industrial solid wastes	246,949	tons/yr
Dead and diseased trees and bushes	15,000	tons/yr
Demolition wastes	67,500	tons/yr
Dead animals	140	tons/yr
Total solid wastes	450,824	tons/yr

The various waste materials making up the above quantities are estimated to be as follows:

	Tons/yr	*Percent*
Garbage	31,898	7.08
Paper and cardboard	91,916	20.39
Plastics, rubber, and leather	6,718	1.49
Canvas and rags	13,570	3.01
Lumber and wood	101,050	22.41
Grass and clippings	8,987	1.99
Industrial oils and thinners	2,575	0.57
Dead animals	140	0.03
Cans, bands, and wire	20,927	4.64
Glass	15,046	3.34
Ashes	70,474	15.63
Pavement and concrete	15,115	3.35
Dirt, sand, plaster, etc.	20,814	4.62
Industrial slurries and sludges	51,512	11.43
Miscellaneous industrial wastes	81	0.02

Estimated current daily per capita waste generation for the various classes of solid wastes and projected solid waste generation in the county are shown below:

PROJECTED REFUSE GENERATION BY GENESEE COUNTY, MICHIGAN

	Present	*1985*	*1995*
Population	455,000	655,000	820,000
Domestic or residential refuse (lb/capita/day)	1.00	1.54	1.84
Commercial and institutional refuse (lb/capita/day)	0.46	0.64	0.75

PROJECTED REFUSE GENERATION BY GENESEE COUNTY, MICHIGAN

	Present	*1985*	*1995*
Industrial refuse* (lb/capita/day)	2.97	3.29	3.47
Wood refuse—trees and bushes (lb/capita/day)	0.18	0.28	0.32
Demolition material (lb/capita/day)	0.31	0.62	0.51
Dead animals (lb/capita/day)	0.0017	0.0017	0.0017
Total refuse* (lb/capita/day)	5.43	6.37	6.89
Total refuse* (tons/day)	1,236	2,087	2,826

* Does not include industrial refuse disposed of by owner either within the industrial plant or outside the county.

There are 31 governmental units in Genesee County that may be concerned with the collection and disposal of solid wastes. A questionnaire survey revealed that only three of these provided municipal collection service: residential waste collection service was provided by the city of Flint for its citizens, and the small villages of Otisville and Otter Lake provided public collection service for their residents. In all other cases, solid waste collection and disposal are either left to the individual or handled by a private collector under agreement with individual householders or under a contract with the local government.

Solid wastes collected by the city of Flint are disposed of at one of two sanitary landfill operations. It is estimated that these sites have sufficient capacity for another 5 to 6 yr. Disposal facilities throughout the remainder of the county consist of dumps operated either by certain of the private collectors or by commercial operators as a business venture. The so-called "tepee" burners are used at some of these latter disposal sites in an effort to reduce the amount of material. These were observed to be exhibiting inefficient burning characteristics and also acting as sources of air pollution.

Based upon the findings of his studies, the consulting engineer made the following principal recommendations for solid waste management in the study area:

1. The Board of Supervisors of Genesee County should create a "County Agency" to dispose of all acceptable solid wastes generated within the county as soon as possible. It is recognized that it is impossible to immediately put the county into the refuse disposal business; however, since existing disposal facilities have such a limited life, steps should immediately be taken by the county to create such an agency that could be operated by either the County Road Commissioners or the Drain Commissioner.

2. The County Agency should immediately enter into contracts with the various governmental units within the county for the disposal of the solid wastes generated within such governmental units. The County Agency should agree to accept all domestic, commercial, and institutional mixed refuse as well as the acceptable solid wastes generated by industry within the county. To establish the costs for performing the service of disposal, the County Agency should have prepared complete plans, specifications, and estimates of construction and operating costs of the proposed facilities so that rates, charges, and/or assessments to be imposed or collected for each specific disposal service may be established.

3. Based upon the contracts entered into with the other governmental units within the county, bonds should be issued to provide funds to purchase the necessary land, the disposal facilities required by the detailed plans and specifications for the construction and equipment, and such other funds as may be necessary.

4. The County Agency should not at this time act as a collecting agency, except in the case of dead animal collection outside the city limits of Flint. If present collection facilities fail in the future to provide adequate services, the County Agency could then enter this operation in addition to the disposal operation. The cost of the collection and disposal of dead animals by utilization of the recommended pathological incinerator should be borne by the county.

5. The costs of disposal of the dead and diseased trees originating on public land outside the corporate limits of cities and villages within the county should also be a charge against the county. Those originating within the corporate limits of cities and villages should have the cost

of disposal charged against the city or village in which the waste originated.

6. The costs for disposal of demolition wastes and all acceptable industrial wastes should be charged against the contributor.

7. The County Agency should construct and operate disposal facilities as follows: (a) A pathological incinerator for animal cremation. (b) A liquid and sludge destructor to dispose of industrial oils and thinners, and slurries and sludges containing combustible material. (c) Land and facilities for disposal of industrial ashes, broken pavement, and concrete. (d) Sanitary landfills at two locations within the county; one to the northeast, and one to the southwest of the city of Flint. Consideration will have to be given prior to 1985 to expanding the operation by two additional disposal sites; one to the northwest, and one to the southeast of Flint, unless better compaction equipment becomes available in the near future at a reasonable cost that could lengthen the life of each of these sites.

8. Plans should be prepared for the ultimate use of the filled land as county parks and recreation centers.

9. Although a County Agency for collection of all solid wastes generated within the county is not recommended at this time, there are certain items (that have come to the attention of the engineers during the study) that should be given consideration by the governmental units that have control over the collection and disposal of refuse within their corporate limits. These are as follows: (a) Standardization of containers for domestic mixed refuse collected by a public agency or where contracts exist between public bodies and private contractors—30 to 32 gal containers constructed of either galvanized metal or plastic material, equipped with suitable handles and a tight-fitting lid, are recommended. (b) Each household should be permitted a maximum of four such containers with a filled weight not to exceed 75 lb per container for once-a-week collection; and all refuse, except tree and brush trimmings, should be placed in these containers. (c) Tree and brush trimmings should be tied into bundles of not over 50 lb each or longer than 4 ft. (d) Those municipalities and townships that do not now have a public collection agency or a contract with a private collector should consider passing such an ordinance to provide a uniform service to the residents at the lowest possible cost. (e) All public and private collectors picking up mixed refuse containing putrescible matter should be required to use drip-proof, enclosed collector trucks, preferably of the compactor type. (f) Open burning of all types of refuse should be prohibited.

PUBLICATION:

Solid waste disposal study; technical report; Genesee County, Michigan, June 1968. Cincinnati, U.S. Department of Health, Education, and Welfare, 1969. [251 p.]

Solid waste collection and disposal study, Harrison County, Mississippi

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PROJECT TYPE: STUDY AND INVESTIGATION **GRANT NO.** D01-UI-00072
GRANTEE: BOARD OF SUPERVISORS, HARRISON COUNTY, MISSISSIPPI
PROJECT DIRECTOR: JOHN W. SMITH, COUNTY ENGINEER'S OFFICE, COURTHOUSE BUILDING,
GULFPORT, MISSISSIPPI 39501
ESTIMATED TOTAL PROJECT COST: $50,000
GRANTEE'S SHARE: $16,667
FEDERAL SHARE: $33,333 [01]
(BY YEAR OF PROJECT LIFE)
DATE PROJECT STARTED: JUNE 1, 1967 **DATE PROJECT ENDED:** OCT. 31, 1968

OBJECTIVES: To demonstrate how new and improved solid waste management practices could solve a regional solid waste problem by making a comprehensive study of solid waste collection and disposal practices within Harrison County, Mississippi, and developing a 20-yr plan for collection and disposal practices that would integrate the present separate solid waste collection and disposal facilities of the individual municipalities into an overall county system.

PROCEDURES, FINDINGS, AND RECOMMENDATIONS: The firm of Albert Switzer & Associates, Inc., Baton Rouge, Louisiana, provided the consulting engineering services required for the project. The study was conducted in three phases.

Phase 1. Population and economic studies. This included estimates of the present and future population to 1986 and population densities; studies of present and estimated future economic and industrial development, existing and proposed land use, and analysis of other pertinent factors of economic growth in the area.

Phase 2. Master waste collection and disposal plan. This included studies of existing collection and disposal systems, estimation of quantities and characteristics of solid wastes generated; and estimates of future solid waste production. Costs of operating existing facilities were obtained.

Phase 3. Economic and financial studies. Comparative costs of constructing and operating the various facilities studied were developed. Net revenues available for financing the recommended project were estimated, as well as additional revenues needed. A proposed rate structure was developed.

A final report is being prepared by the consultant in which his findings and recommendations will appear.

Demonstration grant projects

of barging the West Bank area's solid wastes to swampy areas of lower Jefferson Parish reached by means of Bayonne Barataria, which could be utilized as a site for a sanitary landfill for an indefinite period of time.

The final report on the New Orleans metropolitan area project that includes this study, Public Health Service Publication No. 1932, is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

damaged by operating equipment, and in the future, horizontal probes will be installed. Random sampling of refuse is carried out to determine the character of the material being deposited in the hill.

Delays in procurement of equipment, adverse weather, and equipment breakdowns have slowed progress. Completion of the hill to its planned full height and recreational development of the area will require several more years.

PUBLICATIONS:

ALEXANDER, T. Where will we put all that garbage? *Fortune*, 76(5):148–151, 189–190, 194, Oct. 1967.

What to do with all that rubbish! *Scholastic Newstime*, 3(14):4–5, Jan. 1968.

Investigate the potential benefits of rail haul as an integral part of waste disposal systems

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PROJECT TYPE: STUDY AND INVESTIGATION GRANT NO. D01–UI–00073
GRANTEE: AMERICAN PUBLIC WORKS ASSOCIATION, 1313 EAST 60TH STREET, CHICAGO, ILLINOIS 60637
PROJECT DIRECTOR: KARL W. WOLF, RESEARCH ASSOCIATE, AMERICAN PUBLIC WORKS ASSOCIATION RESEARCH FOUNDATION, c/o MUSEUM OF SCIENCE AND INDUSTRY, ROOM C-209, 57TH AND SOUTH SHORE DRIVE, CHICAGO, ILLINOIS 60637
ESTIMATED TOTAL PROJECT COST: $424,300
GRANTEE'S SHARE: $141,433
FEDERAL SHARE: $178,200 [01]
(BY YEAR OF PROJECT LIFE) $ 58,867 [02]
$ 45,800 [03]
DATE PROJECT STARTED: APR. 1, 1967 DATE PROJECT ENDS: MAR. 31, 1970

OBJECTIVES: To investigate the feasibility of an improved method of solid waste disposal by making a comprehensive evaluation of the costs and benefits obtainable for the collection, transportation, and disposal of solid wastes from urban areas by the use of rail-haul techniques.

PROCEDURES: The project will be conducted in three phases, each of which is expected to take approximately 1 yr to complete. Phase 1 is concerned with the identification, development, and setting up of the rail haul and related solid waste transport and disposal techniques. Phase 2 will deal mainly with implementation of the rail-haul waste disposal concept in cooperation with selected communities. Phase 3 will consist of a comprehensive evaluation of the concept and techniques as demonstrated under actual operating conditions during Phase 2.

The project is being conducted by staff of the American Public Works Association, with contractual professional and consulting services of various types being obtained as needed.

PROGRESS TO DATE: Progress is reported by the grantee as follows:

Considerable progress has been achieved in the first phase. The groundwork for the system has been firmly established and a substantial variety of system elements has been examined. As a result, a number of unpromising alternatives have been identified and discarded, and work is being concentrated on several of the most promising system approaches.

The most promising general approach to date involves various combinations of (1) transfer stations in the generating communities, (2) rail transport to remote sites, and (3) disposal by a modified sanitary landfill in carefully prepared sites.

Several basic transfer station designs have been generated and are now being refined to accommodate all the necessary techno-economic as well as environmental health aspects. The transfer stations are developed with capacities ranging from 50 to 1,000 tons per 8-hr shift to meet the differing needs of the many dissimilar communities across the country.

A substantial part of the transfer station analysis involves an intensive investigation of processing that should occur at that point in the system. This includes shredding, mixing, and particularly compaction of refuse into bales. Compaction promises many potential benefits including sanitation, control of bacteriological activity, economy in shipment, choice of material handling equipment, extension of landfill life, and an improved stability of the fill to widen its range of ultimate uses. Laboratory-scale compaction tests thus far have produced excellent results, and now a production-scale compaction operation needs to be operated to overcome the dangers of extreme extrapolations.

The rail transport as a system segment has even more important beneficial ramifications than was imagined at the start of the study. Intensive work is underway to exploit these potentials fully. This involves scale of operations, transport distances, rail network analysis, loading and unloading practices, disposal operation scheduling, and the application of unit train and rent-a-train concepts among many other aspects. Findings to date suggest that rail transport could be feasible over distances as short as 10 miles to as much as 400 miles. Rail car design is also given some attention in consideration of longer-term system developments.

The study of final disposal methods considered central incineration, composting, sanitary landfill, and disposal at sea. The latter two alternatives currently remain as active and attractive possibilities, particularly with respect to short-term developments. The use of active or abandoned coal strip mines ranks high among the surviving candidates for types of attractive disposal sites desired. The study produced two significant and original possibilities in strip-mine disposal that had not been mentioned in previous studies or the literature.

In the overall, the work to date suggests that waste-rail-haul holds considerable promise of alleviating urban solid waste disposal problems in the near future. There is a very strong likelihood that large savings in the local collection process of participating communities might result as a byproduct.

The grantee's studies during project year 01 indicated that the economic feasibility of the rail-haul concept would depend to a large degree on the ability to compact the wastes to a high density (approximately 80 lb/cu ft) before loading into railroad cars. Investigations disclosed that production equipment suitable for this purpose was not as yet available.

In the early part of 1968, the city of Chicago undertook a demonstration project, whose objectives were to investigate the possibility of developing such compaction equipment (see Grant No. DO1–UI–00170). The staff of this project is assisting in that study, and the work proposed for phase 2 of this project is being held in abeyance pending results of the developmental work in Chicago. Several reports of specialized investigations completed during the project year 01 are being prepared.

PUBLICATION:

American Public Works Association Research Foundation. Rail transport of solid wastes; a feasibility study; interim report: phase one. Cincinnati, U.S. Department of Health, Education, and Welfare, 1969. 168 p.

Evaluation of the Melt-Zit high-temperature incinerator

PROJECT TYPE: STUDY AND INVESTIGATION GRANT NO. D01-UI-00076
GRANTEE: CITY OF BROCKTON
PROJECT DIRECTOR: JOHN E. SULLIVAN, MAYOR, CITY OF BROCKTON, CITY HA ,
BROCKTON, MASSACHUSETTS 02401
ESTIMATED TOTAL PROJECT COST: $67,695
GRANTEE'S SHARE: $22,565
FEDERAL SHARE: $45,150 [01]
(BY YEAR OF PROJECT)
DATE PROJECT STARTED: NOV. 1, 1967 DATE PROJECT ENDED: MAR. 31, 1968

OBJECTIVES: To demonstrate the applicability of a high-temperature incineration process to the disposal of solid wastes.

PROCEDURES, FINDINGS, AND RECOMMENDATIONS: An existing Melt-Zit high-temperature incinerator located at Whitman, Massachusetts, was evaluated using solid wastes from the city of Brockton. Operation tests were performed by Elmer R. Kaiser, Consulting Engineer, Scarsdale, New York. Air pollution emission studies were conducted by Wisconsin Chemical and Testing Company of Milwaukee, Wisconsin. The consulting engineering firm of Fay, Spofford and Thorndike, Inc., Boston, Massachusetts, provided general engineering services associated with the evaluation. The equipment was furnished by the American Design and Development Corporation, Whitman, Massachusetts.

Prior to the tests, the facility was instrumented, equipped with platform and second stack port, and provided with separate water circuits for slag quenching and gas scrubbing. The incinerator was operated for 2 days to train the test crew and establish a full-load rating that could be reliably sustained.

The tests were conducted from Mar. 14 to 23, 1968. The consultant has prepared a draft report concerning the results (currently being reviewed) from which the following summary of findings has been abstracted:

The Melt-Zit facility. The Melt-Zit principle is unique in the art of incineration. The noncombustible fractions of the refuse are melted in a bed of high-temperature coke and drained from the furnace as molten slag and iron. Organic matter in the residue is thereby automatically prevented and complete sterility is achieved. The residue has a high density.

The Melt-Zit pilot installation is basically a vertical, cylindrical shaft furnace with refractory lining. The inside diameter is 3 ft (minimum) and the height is 55 ft.

The molten residue (including metal), which is a slag-like material, is drained through an opening at the base above the hearth; it drops into a quenching tank of water where rapid cooling results in a black granulate and iron pellets.

Refuse is charged midway up the stack through an open charging chute. The refuse feed is continuous. The combustible materials burn in suspension whereas the heavier noncombustibles burn and melt on the surface of the fuel bed.

Performance of Melt-Zit incinerator. Based on the best period of the tests, the capacity of refuse input for the 3-ft diameter furnace was 1.6 tons per hr. The refuse was 90 percent municipal rubbish and 10 percent garbage, by weight.

The operating temperatures in the coke bed were from 2,600 to 3,200 F.

The weight of slag (including metal) produced during the longest test run was 460 lb per ton of refuse, or 23 percent of the weight and 4 percent of the volume of the refuse.

The pilot furnace was operated with direct discharge to the atmosphere at the top. The stack gas scrubber, with which the furnace was equipped, was not used as it would have prevented proper sampling of the gases.

Interruptions were caused by mechanical failures in the slag removing conveyor system and trouble with the flow of slag due to its high viscosity. The maximum length of an uninterrupted run during the tests was 62 hr.

Evaluation of Melt-Zit incinerator. In the state of development and method of operation of the Melt-Zit unit during the March 1968 tests, the pilot incinerator did not perform satisfactorily or reliably. The Melt-Zit incinerator, therefore, needs further development prior to full-scale production. It is believed that the process has sufficient promise to warrant further design and development.

When improved performance can be demonstrated, the rated tonnages can be increased probably up to 25 percent.

A full-scale incinerator of this type will require a secondary combustion chamber to further burn the gases and the particulate matter. The gases could then be cleaned of dust by conventional dust collectors.

It is estimated that the largest practicable size furnace is approximately 8 ft diameter with 15 tons per hr burning capacity.

The technical advantages of the Melt-Zit process are a residue free of putrescible matter, maximum density in landfill, and the elimination of ground water or stream pollution from deposit of incinerator residue.

The most favorable rate of coke consumption during the test period was 1 ton of coke to 8 tons of refuse. It is believed, however, that, by the application of suggested improvements, a ratio of 1 to 20 could be achieved.

Comparative construction and operating costs for a full-scale Melt-Zit plant versus a conventional plant cannot be reliably anticipated from the test experience.

Melt-Zit costs include coke and limestone, which are not common to other incinerators. These additional costs may be offset, however, by additional benefits such as less area required for landfill and reduced costs of residue disposal.

PUBLICATION:

Kaiser, E. R. Evaluation of the Melt-Zit high-temperature incinerator; operation test report, August 1968. Cincinnati, U.S. Department of Health, Education, and Welfare, 1969. [116 p.]

Contract bond financing of multimunicipal incinerator systems

PROJECT TYPE: DEMONSTRATION **GRANT NO.** D01-UI-00077
GRANTEE: BOARD OF WAYNE COUNTY ROAD COMMISSIONERS
PROJECT DIRECTOR: GEORGE R. BINGHAM, SANITARY ENGINEER, WAYNE COUNTY ROAD COMMISSION,
726 CITY—COUNTY BUILDING, DETROIT, MICHIGAN 48226
ESTIMATED TOTAL PROJECT COST: $24,000
GRANTEE'S SHARE: $15,700
FEDERAL SHARE: $ 8,300 [01]
(BY YEAR OF PROJECT LIFE)
DATE PROJECT STARTED: MAR. 1, 1968 **DATE PROJECT ENDED:** JUNE 24, 1968

OBJECTIVES: To develop an organizational structure for the construction and operation of a countywide system of incinerators, and to present the plan and project to appropriate officials of the county's municipalities and representatives of adjoining counties.

PROCEDURES: The first phase of the project will involve preparation of the presentation and development of additional legal and financial data. The financing and service agreements will be drafted by the county's legal consultants, Miller, Canfield, Paddock and Stone, and will include materials prepared by the firms of Kenowet, MacArthur & Co. (financial consultant) and Consoer, Townsend & Associates (engineering consultant). The three consultants will also prepare related and supporting engineering, legal, and financial information and data. A proposed organization will be developed for a policy making and rate review body on which the municipalities would be represented. Visual aids will be prepared to assist in presenting the plan and project. All pertinent material will be consolidated into a report.

In June 1968, the board advised the Bureau of Solid Waste Management that additional studies were being undertaken to revise the proposed solid waste management system and requested that this grant be cancelled. The requested cancellation was effected on June 24, 1968. The Board further indicated its intention to apply for a new grant for the revised project.

Problems and solutions in the regional approach to incineration of solid waste

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PROJECT TYPE: DEMONSTRATION **GRANT NO.** D01–UI–00078
GRANTEE: CENTRAL WAYNE COUNTY SANITATION AUTHORITY
PROJECT DIRECTOR: VIRGIL L. ELLER, SUPERINTENDENT, CENTRAL WAYNE COUNTY SANITATION AUTHORITY, 4901 INKSTER ROAD, DEARBORN HEIGHTS, MICHIGAN 48125
ESTIMATED TOTAL PROJECT COST: $159,995
GRANTEE'S SHARE: $ 53,332
FEDERAL SHARE: $106,663 [01]
(BY YEAR OF PROJECT LIFE)
DATE PROJECT STARTED: JUNE 1, 1967 **DATE PROJECT ENDS:** MAY 31, 1969

OBJECTIVES: To demonstrate the advantages of treating incinerator fly-ash slurry and the resulting savings in costs of water, sanitary sewer maintenance, and general operation.

PROCEDURES: The consulting engineering firm of Pate, Hirn & Bogue, Inc., Detroit, Michigan, is conducting the project in three stages: (1) investigation and evaluation of existing systems, equipment, and materials for fly-ash slurry treatment, and partial recovery of process water, and, concurrently, detailed study of the quantity and characteristics of the waste at the existing incineration plant; (2) preparation of plans and specifications for the proposed fly-ash treatment system, receipt of competitive bids, and construction of the treatment facility; and (3) testing and evaluation of the treatment system, and collection of data on flow, solids, efficiency of solids removal, water saved, and the effects on the sanitary sewers.

PROGRESS TO DATE: A study of the water system of the existing incineration plant has been made to provide a basis for design. By use of an extensive system of weirs and flow meters, the water entering the plant during the 8-day period, Aug. 17 to 24, 1967, was measured and categorized as to use. Of the approximately 550,000 gal a day entering the plant, an average of 85 percent was found to be used for the spray nozzles, 12 percent for quench nozzles and the remaining 3 percent for flushing. Of the total water used for spray and flushing nozzles, 56 percent was found to be lost through evaporation. Average temperature of the discharged fly-ash slurry was 155 F and the pH was as low as 2.2.

On the basis of the foregoing information, the slurry treatment system, consisting of a rectangular settling basin with mechanical sludge removal equipment, was designed and constructed. Provision is made for pH control and coagulation by means of chemical treatment if necessary. The treatment system was expected to be placed in operation during January 1969. Effluent from the settling basin will be recycled through the incinerator plant. Sludge will be hauled to the existing sanitary landfill.

Agricultural benefits and environmental changes resulting from the use of digested sewage sludge on field crops and development of economic and physical characteristic criteria for use in selecting disposal sites

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PROJECT TYPE: DEMONSTRATION GRANT NO. D01-UI-00080
GRANTEE: THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO
PROJECT DIRECTOR: FRANK E. DALTON, ACTING CHIEF ENGINEER, THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO, 100 WEST ERIE STREET, CHICAGO, ILLINOIS 60611

ESTIMATED TOTAL PROJECT COST:	$914,000
GRANTEE'S SHARE:	$305,000
FEDERAL SHARE:	$329,000 [01]
(BY YEAR OF PROJECT LIFE)	$138,000 [02]
	$142,000 [03]

DATE PROJECT STARTED: APR. 1, 1967 DATE PROJECT ENDS: MAR. 31, 1970

OBJECTIVES: To demonstrate the agricultural benefits and environmental changes resulting from the application of digested sewage sludge to field crops and to develop the economic and physical characteristic criteria for use in selecting sites for this improved method of solid waste disposal.

PROCEDURES: The Agronomy Department of the University of Illinois is conducting laboratory, greenhouse, and field investigations to determine: (1) the most practical amount, frequency, economical method, and time for applying digested sludge on crop land; (2) the probability of contaminating surface water and ground water aquifers with pathogens and molecular organic and inorganic ions; (3) the change in soil physical and chemical characteristics to be expected from frequent heavy applications of digested sludge; and (4) the crops and cropping systems that will provide maximum absorption of certain essential and nonessential elements supplied to the soil by digested sludge applications.

The Harza Engineering Company, Chicago, Illinois, has investigated possible disposal sites for digested sludge from the district, recommended the most suitable sites for this purpose, and evaluated the routes and means for conveying sludge to the selected sites.

PROGRESS TO DATE:

1. Agronomy Department, University of Illinois

A site on the N.E. Agronomy Research Center in Will County was chosen for the field investigation facility. An instrument house has been constructed, and lysimeter plots have been installed.

As a preliminary study during the summer of 1967, soybeans were planted in 24 lysimeters, 3 ft in diameter and 38 in. deep, located on the agronomy South Farm at Urbana, and treated with various rates of digested sludge and water. During the growing season, as much as 10 in. of sludge was applied in 1-in. applications at 8-day intervals. Soybeans growing on lysimeters and receiving sludge applications showed a marked increase in growth. The lysimeters were established in galvanized metal containers in 1940, and the soils now have an extraordinarily high concentration of zinc. Soybeans growing on untreated lysimeters suffered a zinc toxicity, whereas those treated with sludge were not affected by the high zinc concentration.

During the 1968 growing season, the lysimeters on the South Farm were planted to Reed canary grass and grain sorghum. Results showed that nitrogen and manganese content in the plant tissue increased as the sludge application rates increased. As with the soybeans, the plant up-take of zinc appeared to increase with the application of digested sludge.

Corn and kenaf plots were treated with digested sludge at the N.E. Agronomy Research Center during the 1968 growing season. Although the plots did not receive the first application of sludge as early as would have been desirable, the results were quite favorable. The average yields were:

Corn

Sludge application rate, in./wk	Average yield, bu/acre
0	66.5
¼	96.2
½	114.2
1	111.9

Kenaf

Sludge application rate, in./wk	Average yield, tons/acre
0	2.1
¼	3.6
½	3.7
1	3.7

The ability of the sludge to support the germination and seedling development of corn and soybeans was investigated. Three sludge fractions were used: the sludge itself; the supernatant (SI) obtained by centrifuging the sludge at 6,000 × g for 15 min; and the supernatant (SII) obtained by centrifugation of SI at 20,000 × g for 60 min. All three fractions had an inhibitory effect on seed germination and seedling development. Additional studies of the SII supernatant indicate the presence of a volatile, ether-soluble compound(s) toxic to soybeans only. Since the ashes of SII were nontoxic, toxicity seemed to be caused by organic rather than inorganic compounds.

Laboratory and greenhouse studies have been initiated to obtain information concerning the fertility value of digested sludge, amounts of supplemental potassium fertilization required for high yields of corn and soybeans on sludge-treated land, the accumulation in soils of heavy elements that result from sludge applications, and methods of reducing nitrate accumulations in soil drainage water.

The above indicates, in a general way, some of the studies underway. Many of the studies will yield valuable information in directing the future investigative effort.

II. Harza Engineering Company

A summary report on site and route selection studies has been completed. Recommendations for a staged program of land reclamation with the use of digested sludge include the following:

Phase 1. Initiation of a sludge utilization experimental program for late 1967 on a small plot at the West–Southwest Plant.

Phase 2. Immediate acquisition of a 1,700-acre site in South-Cook County, south of Tinly Park, for operations initiated in 1968. Sludge utilization at this site would be increased from about 30 tons of dry solids per day in 1968 to 220 tons per day in 1971.

Phase 2C. During the period 1968 through 1971, development, with other organizations, of cooperative sites for purposes of demonstrating benefits and possibly obtaining substantial areas for sludge utilization in future years.

Phase 3. Acquisition of a 21,500-acre site at Essex, south of the Kankakee River. This site would be designed to utilize beneficially the forecasted sludge production of the Sanitary District to the year 2015. The sandy soils at the Essex site now have limited agricultural production. Applied sludge, with supplemental irrigation, would increase crop production and agricultural income by about $580,000 per year.

PUBLICATION:

Harza Engineering Company. Land reclamation project; an interim report. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. [358 p.]

Illinois auto salvage waste pollution control

PROJECT TYPE: STUDY AND INVESTIGATION GRANT NO. D01-UI-00081
GRANTEE: ILLINOIS AUTO SALVAGE DEALERS ASSOCIATION
PROJECT DIRECTOR: LARRY GODDARD, EXECUTIVE DIRECTOR, ILLINOIS AUTO SALVAGE DEALERS ASSOCIATION, 601 WEST MONROE STREET, SPRINGFIELD, ILLINOIS 62704
ESTIMATED TOTAL PROJECT COST: $42,820
GRANTEE'S SHARE: $15,820
FEDERAL SHARE: $27,000 [01]
(BY YEAR OF PROJECT LIFE)
DATE PROJECT STARTED: JUNE 1, 1967 DATE PROJECT ENDED: MAY 31, 1968

OBJECTIVES: To develop guidelines for the collection, handling, storage, and processing of abandoned automobiles to serve as the basis of a solid waste disposal program for Illinois Auto Salvage Dealers for the purpose of improving current disposal practices, eliminate existing health and welfare problems resulting from current practices, and prevent similar problems from developing in the future.

PROCEDURES, FINDINGS, AND RECOMMENDATIONS: The consulting engineering firm of Crawford, Murphy and Tilly, Inc., Springfield, Illinois, conducted the study that included: (1) development of data concerning the location and distribution of auto salvage dealers in Illinois, their current activities, and their immediate and expected future solid wastes handling procedures and problems; this information was obtained by field and questionnaire surveys of dealer operations; (2) special surveys of some 10 dealer operations to check and analyze critical operations, such as those under surveillance by health, welfare, or other public regulatory agencies; (3) study of solid wastes combustion, metal shredding, and compaction processes and auto-scrap utilization to check the feasibility of processes, handling, storage, and disposal practices that are compatible with public interest requirements; (4) an economic study, indicating the impact and effect of upgrading the handling, processing, storage, and disposal of solid wastes to meet present and future public interest requirements. (5) preparation of suggested guidelines for industry standards for the collection, handling, storage, processing, and disposal of its wastes to meet public requirements.

Field surveys have been completed. Some preliminary findings and conclusions reported by the grantee are as follows:

1. It appears quite obvious that the market preference for clean scrap will bring about increasing movement to the fragmentizing installations. At the present time, these costly plants are taking about 50 percent of the Illinois auto body scrap, and with the market preferring a premium of about $10 per ton for this decontaminated scrap over the old baled waste, this rules out the practicality of installing regional body burning plants. The prime purpose of a regional burner would, of course, be to prepare the scrap for baling, and bales have poor marketability except in limited areas.

2. Illinois municipalities are effectively disposing of abandoned vehicles. Their actions follow local ordinances and the Illinois Statutes that provide for removal of the "forgotten" vehicle from both public and private property.

Only in their efforts to facilitate the flow of auto scrap have municipalities lagged somewhat. Continuous adjustment takes place between the salvage dealer and the city. Frequent insistence by the city that the salvage dealer pick up these abandoned vehicles is accompanied by efforts by the city to relocate the dealer outside the corporate limits. The dependence of the municipality upon auto salvage dealers illustrated in the study of municipal disposal costs is too often overlooked.

The gross municipal costs of handling abandoned vehicles varies from $27.56 per vehicle, where the city handles all processing, to $3.73 per vehicle, where a local salvage dealer is authorized to handle the processing. Any such municipal costs represent time and equipment taken from security, public works, and public health duties and should obviously be held to a minimum.

3. There is a great necessity for an educational program through a comprehensive public relations project to educate the public, the auto salvage dealers themselves, and public officials of the changes in operation and legislation needed to cope with new concepts that must be initiated to ensure feasible solutions to the problem.

Unforeseen circumstances have delayed completion of the consultant's final report on the project, and his final conclusions and recommendations are not available at this time.

With the cooperation of the Governor's office, the Auto Salvage Dealers Association sponsored a conference "Our Junked Car Dilemma, Pollution, and Waste Disposal Control," which was held in Springfield, Illinois, in March 1968. The purpose of the conference was to focus public attention on the problems concerned and to bring together a cross section of industry and government leaders who are directly involved with the auto salvage waste control problem.

Control of dust in handling of solid wastes

PROJECT TYPE: STUDY AND INVESTIGATION GRANT NO. D01-UI-00082
GRANTEE: SOUTHEASTERN OAKLAND COUNTY INCINERATOR AUTHORITY
PROJECT DIRECTOR: ALLAN J. KRONBACH, ASSISTANT GENERAL MANAGER, SOUTHEASTERN OAKLAND COUNTY INCINERATOR AUTHORITY, P.O. BOX 1248, BERKLEY, MICHIGAN 48072

ESTIMATED TOTAL PROJECT COST:	$40,000
GRANTEE'S SHARE:	$13,333
FEDERAL SHARE:	$26,667 [01]
(BY YEAR OF PROJECT LIFE)	

DATE PROJECT STARTED: JUNE 1, 1967 DATE PROJECT ENDED: MAY 31, 1968

OBJECTIVES: To evaluate the feasibility and economic practicability of controlling the spread of dust into the atmosphere within the incinerator building and outside environment during the handling of solid waste material for disposal.

PROCEDURES, FINDINGS, AND RECOMMENDATIONS: The project was conducted by the consulting engineering firm of Black and Veatch of Michigan, who studied the incinerator complex from the standpoint of dust sources, existing ventilating system, and airflow problems, and developed recommendations for various dust control systems. The consultant's principal findings, summarized from the draft copy of his final report, are as follows:

1. The major dust generation in the incinerator plant is caused by free fall and resultant impact of relatively dry refuse. Almost one-half of the weight of dust in suspension consists of particles in the 10 to 43 micron size range.

2. Careful operation of the refuse cranes can minimize the dust generated by plant handling operations. The dust generated by truck dumping cannot be appreciably reduced by operating procedures.

3. Installation of adequate dust control systems in the storage pit and charging floor area will require from $419,300 to $692,900 in capital investment funds.

4. Annual costs for these dust control systems vary from $68,100 to $101,800.

5. A recirculating type dust control system incorporating a low flow ventilating system and a medium velocity air curtain has the lowest initial and annual costs of the systems considered. Local regulations, however, may not permit the use of a recirculating type system.

During the period April 29 to May 3, 1968, the Michigan Department of Public Health, Division of Occupational Health, made an evaluation of the dust concentrations at the incinerator to comply with a request from the incinerator authority. The State department's conclusions and recommendations appear below:

CONCLUSIONS: (1) The operations involved in handling bulk trash at an incinerator such as truck dumping or tipping and crane operation are productive of dust concentrations that are significantly in excess of safe health limits. (2) Employees at the tipping floor, charging floor, and crane operators have potential exposure to these dusts. Although not investigated during this study, employees at the ash-pit dumping locations may also be so exposed. (3) The particle size of the airborne dust is in the significant size range to produce pulmonary disease. (4) The free silica content of the dust is high enough to be significant in the production of silicosis. (5) In this incinerator, the crane cab operators are in enclosed cabs with a filtered air supply. It is assumed that crane operators without such equipment would also have a high dust exposure.

productive of dust creation and dissemination
RECOMMENDATIONS: (1) The operations

should be enclosed as much as is feasible and provided with exhaust ventilation; i.e., dumping location, storage pit, furnace hoppers. (2) Such exhaust ventilation systems should incorporate suitable dust collection equipment, and the air should then be exhausted to the outside. The Michigan Department of Public Health, along with many other states, does not permit the recirculation of hazardous dusts. (3) Provision should be made for an adequate supply of tempered makeup air to compensate for the volume being exhausted to provide controlled airflow and to prevent the existence of a negative pressure situation within the building.

In future incinerator design, every attempt should be made to eliminate the free fall of trash and extensive crane travel.

Western Jefferson County solid waste disposal study

PROJECT TYPE: STUDY AND INVESTIGATION GRANT NO. D01–UI–00064
GRANTEE: CITY OF LAKE MILLS, WISCONSIN 53551
PROJECT DIRECTOR: BRUCE O. FRUDDEN, MEAD AND HUNT, INC., P. O. BOX 5247,
MADISON, WISCONSIN 53705
ESTIMATED TOTAL PROJECT COST: $6,500
GRANTEE'S SHARE: $2,167
FEDERAL SHARE: $4,333 [01]
(BY YEAR OF PROJECT LIFE)
DATE PROJECT STARTED: JUNE 1, 1967 DATE PROJECT ENDED: MAY 31, 1968

OBJECTIVES: To demonstrate how new or improved solid waste management procedures could solve a regional solid waste problem by determining the feasibility of a joint solid waste disposal system for the communities of Fort Atkinson, Jefferson, Lake Mills, Waterloo, Johnson Creek, and the surrounding rural townships.

PROCEDURES, FINDINGS, AND RECOMMENDATIONS: The study was performed by the consulting firm of Mead and Hunt, Inc., Madison, Wisconsin, and included consideration of the following items: (1) population and projected increase; (2) type and quantity of refuse and projected increase; (3) present collection methods, frequency of pick-ups, equipment, personnel, and costs; (4) review of available methods of disposal including landfill, incineration, garbage grinding and digestion, milling, and others; (5) analysis of refuse disposal projects that appear feasible for the area being studied; (6) cost estimates for each type of project analyzed, including capital expenditure and annual operating costs.

Major conclusions reached by the consultant are as follows: (1) A sanitary landfill disposal operation, centrally located and jointly owned by the five communities, will be the most economical system. (2) A jointly owned collection system of container trains, used in conjunction with transfer packer trucks, will be the most economical of the collection systems investigated. (3) The annual cost of the proposed jointly-owned collection and disposal system will be approximately $132,000 or $6.33 per capita. If the surrounding 10 townships are included as customers, the annual cost to the communities will be $109,000, or $5.22 per capita. The initial cost of the system will be $346,100, or $472,800 if the surrounding townships are included.

The consultant's recommended action is that the five communities jointly operate a sanitary landfill and also jointly operate a container train system of collection vehicles in conjunction with transfer packer trucks. The townships should be approached as potential customers.

Tocks Island regional-interstate solid waste management study

PROJECT TYPE: STUDY AND INVESTIGATION **GRANT NO. D01-UI-00087**
GRANTEE: *TOCKS ISLAND REGIONAL ADVISORY COUNCIL
PROJECT DIRECTOR: FRANK W. DRESSLER, EXECUTIVE DIRECTOR, TOCKS ISLAND REGIONAL ADVISORY COUNCIL, 612 MONROE STREET, STROUDSBURG, PENNSYLVANIA 18360

ESTIMATED TOTAL PROJECT COST:	**$192,000**
GRANTEE'S SHARE:	**$ 64,000**
FEDERAL SHARE:	**$ 56,340 [01]**
(BY YEAR OF PROJECT LIFE)	**$ 71,660 [02]**

DATE PROJECT STARTED: JUNE 1, 1967 **DATE PROJECT ENDS: JUNE 30, 1969**

OBJECTIVES: (1) To demonstrate regional interagency solid waste planning under the leadership of a new type of regional agency consisting of representatives from the six member counties in the tri-state region affected by the Delaware Water Gap National Recreation Area.

(2) To develop needed information and plans for optimum solid waste management facilities for the interstate region influenced by the Delaware Water Gap National Recreation Area.

(3) To explore and demonstrate the feasibility of resolving a solid waste disposal problem on a regional basis through interlocal and/or interlocal, interstate cooperation and action.

PROCEDURES: In general, the study will involve the participation of representatives of all Federal, interstate, State, and local governmental agencies and civic groups that have basic responsibilities for or major interests in the management of solid wastes and the general protection of the environmental health of the area expected to be influenced by the development of the Delaware Water Gap National Recreation Area. The council will establish and utilize three committees—a steering committee, a technical advisory committee, and a solid waste management committee—each composed of one or more members of each of the participating agencies to assure the successful execution and eventual implementation of the recommendations of the study.

The council will retain the firm of Candeub, Fleissig and Associates, Newark, New Jersey, to provide the necessary consulting services. The study will be carried out through a combination of council staff and consultant activities, supplemented with information and studies to be provided by participating agencies.

The specific work program will consist of the elements which follow.

Determination of the magnitude of the problem. This will consist of an overall look at the entire problem in the study area including such items as identification of geographic sub-areas in the region, study of the characteristics of solid waste and elements involved in its disposal, present and future distribution of solid waste generators in the area, amount of solid waste expected from the national park and many other pertinent considerations. From this information, conclusions will be drawn as to the overall magnitude of the problem to be faced in the future, and a series of objectives developed for the present study.

Study design. This will include the development of a detailed prospectus and procedure for undertaking the entire study.

Research and analysis. Present solid waste disposal methods and practices in the area will be defined together with an indication of their adequacy or of any existing problems. Present practices that appear applicable to the region will be identified including costs, advantages, and disadvantages. Existing legislation applicable to the solid waste problem in the region will be reviewed in each of the States. This will relate to the powers of the States, counties, and municipalities to undertake and regulate solid waste activities. The effect of solid waste disposal practices on air, sewer, and water pollution and facilities will be considered.

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* This is an organization of representatives (principally the top elected officials) from the six member counties in the tri-state region affected by the Delaware Water Gap National Recreation Area. The six counties included in this region are: Monroe, Northampton, and Pike in Pennsylvania; Orange in New York; Sussex and Warren in New Jersey.

Possible formulation of solid waste "model." The feasibility of developing a mathematical model that will formalize the relationships that exist between the production of solid wastes and their eventual disposal will be investigated. Alternate possibilities for meeting the present and future solid waste needs of the area will be developed. In the event that it does not prove feasible to develop a satisfactory model, then the factors involved will be evaluated by the council staff, consultant, and technical committee, and alternate possibilities developed based on this evaluation.

Development of solid waste plans. Alternate solid waste disposal plans will be developed for serving the area now, by 1975, and by 1990. These will be reviewed by Tocks Island Regional Advisory Council, the various committees, and other agencies involved. Those plans that appear most appropriate in terms of effectiveness, cost, and acceptability to the region will be identified.

Program for implementation. A program for implementation will be developed indicating the necessary steps for immediate action needed to carry out the plans selected.

PROGRESS TO DATE: A report setting forth a detailed study design was completed in May 1968. This identifies the tasks to be undertaken in the study, the activities to be performed toward the completion of each task, the approximate sequence in which these activities are to be performed, and the proposed roles of the various participants in carrying out the activities.

Alternative solid waste management plans are being developed from which the most effective plan for the study area will be determined. The technical and administrative characteristics of the alternative plans are being reviewed and analyzed at joint meetings of the Steering and Technical Advisory committees. Projections of population and waste generation have been completed. Waste sources and collection methods and systems have been identified. A legislative study has been completed that identifies existing legal constraints on the regional approach to solution of the solid waste problem and specifies new governmental and intergovernmental arrangements that may be required for a regional management approach.

A mathematical model is being developed that will provide a method for estimating costs of alternative solid waste management systems. The model will be finalized in two sections, the first of which will provide a description and technical justification of the model and procedures, whereas the second section will consist of worksheets and forms to be used when employing the model.

Incinerator water treatment system and Peabody scrubber test

PROJECT TYPE: DEMONSTRATION **GRANT NO. D01-UI-00089**

GRANTEE: WHITEMARSH TOWNSHIP AUTHORITY

PROJECT DIRECTOR: WAYNE SEIFERT, PLANT SUPERINTENDENT (INCINERATOR AND SEWAGE), WHITEMARSH TOWNSHIP AUTHORITY, TOWNSHIP BUILDING, LAFAYETTE HILL, PENNSYLVANIA 19444

ESTIMATED TOTAL PROJECT COST:	**$241,565**
GRANTEE'S SHARE:	**$ 80,522**
FEDERAL SHARE:	**$121,163 [01]**
(BY YEAR OF PROJECT LIFE)	**$ 26,940 [02]**
	$ 12,940 [03]

DATE PROJECT STARTED: JUNE 1, 1967 **DATE PROJECT ENDS: MAY 31, 1970**

OBJECTIVES: To test the effectiveness of improved solid waste disposal practices consisting of a waste-water treatment system for clarifying and reusing waste water in incinerators and to test the effectiveness of a flooded baffle Peabody scrubber that uses recirculated treated water.

PROCEDURES: The consulting engineering firms of Abraham Michaels, P. E., Philadelphia, Pennsylvania, and Roy F. Weston, West Chester, Pennsylvania, are providing engineering services in connection with the design, construction, and testing of the water treatment plant and the Peabody scrubber.

A waste-water handling, treatment, and recirculation system will be constructed at the existing incinerator. This will include the use of chemicals for pH control and precipitation, a clarifier for solids removal, and lagoons for final clarification. The water to be treated is used for gas cooling, siftings sluicing, residue quenching, and the Peabody scrubber.

Tests will be made to evaluate the efficiency of the Peabody scrubber. These will include overall emission quantities for particulates and for gases, such as CO, CO_2, and oxides of sulphur and nitrogen. An effort will be made to test the efficiency of the collector by sampling gases before and after the scrubber.

The efficiency of the several components of the water treatment system will be evaluated by collection of samples at various points in the process and analyses for pH, BOD, and suspended and settleable solids.

City water will be used for the incinerator until 25,000 tons of solid wastes have been incinerated. Following this, effluent from a nearby secondary sewage treatment plant will be used.

PROGRESS TO DATE: The waste-water handling, treatment, and recirculation system, consisting of a clarifier, two lagoons, and a pumping station, was completed in August 1968. The initial gas and water tests were conducted during the same month. Water samples were collected at several points in the treatment process. Samples of gases were collected at entrance to and exit from the Peabody scrubber.

A number of problems and limitations were disclosed in testing the incinerator. Based on results obtained, an exploratory stack sampling program may be required before additional full-scale tests are run.

The water treatment and recirculation system has been operating since completion with the use of city water. No significant operating or maintenance problems have been encountered.

Study and investigation of solid waste in Appalachian regional demonstration health area

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PROJECT TYPE: STUDY AND INVESTIGATION GRANT NO. D01–UI–00090

GRANTEE: WEST VIRGINIA STATE DEPARTMENT OF HEALTH

PROJECT DIRECTOR: O. R. LYONS, DIRECTOR, SOLID WASTE DISPOSAL PLANNING, WEST VIRGINIA STATE DEPARTMENT OF HEALTH, CHARLESTON, WEST VIRGINIA 25305

ESTIMATED TOTAL PROJECT COST:	$14,425
GRANTEE'S SHARE:	$ 4,825
FEDERAL SHARE:	$ 9,600 [01]
(BY YEAR OF PROJECT LIFE)	

DATE PROJECT STARTED: JUNE 1, 1967 DATE PROJECT ENDED: MAY 31, 1968

OBJECTIVES: To demonstrate how new or improved solid waste management techniques, developed on an intercounty basis, could solve the solid waste problems of an economically depressed area designated by the State of West Virginia as a demonstration area for regional health services.

PROCEDURES, FINDINGS, AND RECOMMENDATIONS: The study was carried out by members of the engineering faculty of the West Virginia Institute of Technology. The study area consisted of the following nine counties in southern West Virginia: Fayette, Mingo, Wyoming, Raleigh, Summers, Logan, McDowell, Mercer, and Monroe.

Surveys were conducted to determine the quantity and character of solid waste generated and existing waste disposal practices. Recommendations were developed for a solid waste management system that would serve the needs of the area. During the course of the study, meetings were held with the Southern West Virginia Regional Health Council so that the body could contribute its ideas and concerns with respect to solid wastes planning.

The consultant's principal findings and recommendations, as presented in his final report, are summarized:

In the study area, 464 full-time personnel collected solid waste, mostly from private households. Of that number, 219 were employed by public agencies and 245 by the 54 private firms operating in the area. A total of 40 compactor trucks and 88 other trucks were used for solid waste handling. Collection service was available for about half of the estimated study-area population of 440,000.

Two scrapers and eight tractors were used on a part-time basis to dispose of solid waste. Three of the counties have no disposal equipment at all. Virtually all disposal within the study area is in open dumps or substandard landfills. Many of these open dumps were found to be burning, and indications are that they burn continuously.

A study of the current solid waste collection and disposal practices in this nine county area indicated the most acute problem was disposal of household refuse after collection. The collection in the urban sections was adequate; however, only one disposal operation could be classed as reasonable.

The initial step in developing a solid waste management plan was to define 12 "collection areas" or regions within the study area; the boundaries of the region were established on the basis of population density and the existing highway system. These regions included the most densely populated portion of the study area and contained over 70 percent of the total population and about 40 percent of the total land area. A recommended solid waste management plan, involving 11 of these regions, was developed for the study area. (One region was not included because its geographical characteristics were such as to virtually exclude it from the study area.) After defining the regions, the plan would be implemented in three phases:

Phase I. Establishment of sanitary landfills in five of the regions, with sufficient capacity to provide immediate disposal facilities for about 200,000 persons and eventual service to the entire population.

Phase II. Establishment of transfer stations in the remaining six regions. Solid wastes would be hauled from these locations to an appropriate landfill site for ultimate disposal.

Phase III. Establishment of a collection system in the portion of the study area lying outside the 11 regions. This would require adoption of unconventional methods, since this portion of the area is sparsely populated. Use of strategically located portable collection bins or of one-man collection vehicles are two possibilities that could be explored. In addition to the foregoing, all those areas in the regions now without collection service should be provided with such service. All solid wastes collected would be transported to an appropriate sanitary landfill as established under Phase I.

To ensure overall uniformity in service and performance it is recommended that the entire program be supervised by one central authority.

NOTE: Since completion of this project, the Southern West Virginia Regional Health Council has received a grant from the Appalachian Regional Commission to implement Phase I of the above plan.

Bulk refuse crusher facility

PROJECT TYPE: DEMONSTRATION **GRANT NO.** D01–UI–00091

GRANTEE: CITY OF BUFFALO, CITY HALL, BUFFALO, NEW YORK 14202

PROJECT DIRECTOR: LEONARD S. WEGMAN, LEONARD S. WEGMAN CO., 101 PARK AVENUE,
NEW YORK, NEW YORK 10017

ESTIMATED TOTAL PROJECT COST:	$805,350
GRANTEE'S SHARE:	$268,450
FEDERAL SHARE:	$253,467 [01]
(BY YEAR OF PROJECT LIFE)	$260,063 [02]
	$ 23,400 [03]

DATE PROJECT STARTED: JUNE 1, 1967 **DATE PROJECT ENDS:** DEC. 31, 1969

OBJECTIVES: To demonstrate the feasibility of reducing the size of bulky burnable solid wastes by a heavy duty impact crusher to permit disposal by incineration, which would not otherwise be possible because of the limited size of incinerator charging openings.

PROCEDURES: The consulting firm of Leonard S. Wegman Company, New York City, will provide all engineering services associated with construction of the facility and will furnish necessary services for obtaining operational data, data analysis, and reporting of results.

When the construction has been completed, the city will arrange to collect all oversize solid wastes separately from general garbage and refuse for processing in the Bulk Refuse Crusher. The crushed bulky wastes will be burned in the existing incinerator. Accurate records will be kept of the quantities, weight, and characteristics of material processed. Data on power consumption costs of maintenance and labor and other costs will be obtained to evaluate the economics of the operation.

PROGRESS TO DATE: Construction contracts were awarded by the city in August 1967, and construction of the facility is complete except for the electrical controls. This work was expected to have been finished by March 1969, leaving 9 mo for operation and evaluation of the installation.

Economic feasibility of composting refuse and sewage sludge in southeastern Michigan

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PROJECT TYPE: STUDY AND INVESTIGATION GRANT NO. D01–UI–00092
GRANTEE: CITY OF RIVERVIEW, 17700 FORT STREET, RIVERVIEW, MICHIGAN 48194
PROJECT DIRECTOR: MILTON D. REDICK, CIVIL ENGINEER, JOHNSON & ANDERSON, INC.,
2300 DIXIE HIGHWAY, PONTIAC, MICHIGAN 48055
ESTIMATED TOTAL PROJECT COST: $9,780
GRANTEE'S SHARE: $3,260
FEDERAL SHARE: $6,520 [01]
(BY YEAR OF PROJECT LIFE)
DATE PROJECT STARTED: JUNE 1, 1967 DATE PROJECT ENDED: NOV. 15, 1967

OBJECTIVE: To evaluate the economic feasibility of constructing a refuse and sewage sludge composting plant in the city of Riverview with particular attention to the market value and quantity of the finished compost and salvaged material.

PROCEDURES, FINDINGS, AND RECOMMENDATIONS: The consulting engineering firm of Johnson and Anderson, Inc., Pontiac, Michigan, conducted the study. Existing marketing channels in the southern States for refuse compost were reviewed and evaluated. The present marketing channels for chemical fertilizer in the Michigan area were surveyed and analyzed. The methods of bulk shipping, primarily rail and truck, were investigated. Capital and operating costs for refuse composting plants of various capacities were developed.

The major conclusions presented in the consultant's final report are: (1) There now exists a specialized market in the adjacent Michigan-Ohio region capable of absorbing 25,000 tons of compost annually. (2) Total cost of producing compost in a plant with a capacity of 300 tons of refuse per day is estimated between $8.47 and $9.40 per ton. (3) An estimated income of $6.74 per ton of refuse can be expected from salvaging and the sale of compost. An additional income of at least $1.00 per ton of refuse can be expected after 2 or 3 yrs of successful plant operation. The net cost of disposal would then be between $0.74 and $1.90 per ton of refuse.

All of the above conclusions are based upon the condition that: (1) contracts can be secured to process the refuse from approximately 190,000 people, and (2) that there is no immediate development of additional compost manufacturing capacity in the region.

The marketing study of the report also includes a discussion of the history of composting within the United States, and the principal reasons for success or failure of the different plants.

Demonstration of countywide solid waste management program and feasibility of sanitary landfill operations utilizing a multifunction machine

PROJECT TYPE: DEMONSTRATION GRANT NO. D01-UI-00093
GRANTEE: NIAGARA COUNTY SOLID WASTE AGENCY, COURT HOUSE, LOCKPORT, NEW YORK 14094
PROJECT DIRECTOR: WILLIAM M. FRIEDMAN, JR., ASSISTANT COMMISSIONER FOR ENVIRONMENTAL HEALTH, NIAGARA COUNTY HEALTH DEPARTMENT, 525 BEWLEY BUILDING, LOCKPORT, NEW YORK 14094
ESTIMATED TOTAL PROJECT COST: $643,069
GRANTEE'S SHARE: $214,356
FEDERAL SHARE: $363,017 [01]
(BY YEAR OF PROJECT LIFE) $ 65,696 [02]
DATE PROJECT STARTED: JUNE 1, 1967 DATE PROJECT ENDS: FEB. 28, 1970

OBJECTIVES: (1) To demonstrate how new and improved solid waste management techniques could solve a regional solid waste problem, by determining the feasibility and advantages of consolidating and centralizing numerous individual local, public, private, and industrial solid waste disposal operations into a countywide solid waste management program to be carried out by the Niagara County Solid Waste Agency. (2) To demonstrate the feasibility of operating a sanitary landfill utilizing a newly-developed machine that combines in one unit the operations of trench excavation, refuse compaction and placement in the trench, and provision of a compacted earth cover over the compacted refuse immediately after placement.

PROCEDURES: The Niagara County Solid Waste Agency will purchase two sanitary landfill sites and, with the assistance of an engineering consultant, will prepare detailed plans for the proper development of each. After the sites have been prepared, personnel hired, and all equipment, material, and supplies obtained, the final arrangements will be made for actual operation.

The smaller eastern site (about 25 acres) will be operated as a conventional sanitary landfill during the first year. During this period, an economic study will be conducted to determine the feasibility of converting this site to a transfer station. Consideration will also be given to the future provision and operation of an incinerator at this site, with residue disposal either onsite or at the main westerly landfill.

The western, or main site (about 100 acres), will be operated using the D&J Refuse Machine, which is a multifunction unit designed to perform the operations indicated under objective 2 above.

Complete operating records will be maintained at each site. These will include: quantity and type of waste received; use of equipment including both operating time and downtime; man-hours devoted to the various operations; a complete record of all operating difficulties and operating costs.

Before and during the entire operation, adjacent counties and municipalities will be invited to participate. If such cooperative participation appears feasible, due consideration will be given to expanding the membership of the agency.

Thirteen existing municipal solid waste disposal sites, none of which are operated in a sanitary manner, will be closed and rehabilitated, thus eliminating nuisance conditions.

PROGRESS TO DATE: Enabling legislation authorizing formation of the Niagara County Solid Waste Disposal District is currently in the State legislature. Approval in the immediate future is anticipated. During 1968, the D&J

Refuse Machine has been used only in limited landfill operations. Purchases of land and equipment and full-scale operation of the machine have been delayed pending formation of the disposal district.

Comprehensive study of solid waste disposal—Cascade County, Montana

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PROJECT TYPE: STUDY AND INVESTIGATION GRANT NO. D01–UI–00095
GRANTEE: BOARD OF COUNTY COMMISSIONERS, COUNTY OF CASCADE, COURT HOUSE
PROJECT DIRECTOR: JOHN A. GOOGINS, HEALTH OFFICER, CITY—COUNTY HEALTH DEPARTMENT,
1130 17TH AVENUE SOUTH, GREAT FALLS, MONTANA 59401
ESTIMATED TOTAL PROJECT COST: $57,000
GRANTEE'S SHARE: $19,000
FEDERAL SHARE: $38,000 [01]
(BY YEAR OF PROJECT)
DATE PROJECT STARTED: JUNE 1, 1967 DATE PROJECT ENDED: SEPT. 30, 1968

OBJECTIVES: To demonstrate how new or improved solid waste management techniques could solve a regional solid waste problem by developing a comprehensive plan for the efficient and effective storage, collection, and disposal of solid wastes generated in the county of Cascade.

PROCEDURES, FINDINGS, AND RECOMMENDATIONS: The study was accomplished through the joint efforts of the county of Cascade, the cities of Great Falls and Belt, and the towns of Cascade and Neihart. The firm of Thomas, Dean and Hoskins, Inc., Great Falls, Montana, provided consulting engineering services and prepared the final report from which the following material has been abstracted:

Field surveys were conducted and available data collected to provide information concerning the existing solid waste collection and disposal practices in the county. The estimated 1968 population of the county was 91,800. Of this total, some 80,000 people were residing in Great Falls and environs, and about 4,200 people were living in the 13 smaller communities having existing solid waste disposal sites.

Only Great Falls and one other community have organized solid waste collection systems, whereas the remaining communities leave the storage and disposal of solid wastes to the individual. For these latter, infrequent disposal of refuse coupled with inadequate storage facilities produce high potential health hazard areas. From a health standpoint, these insanitary refuse storage areas are more critical than the inadequate disposal sites because they are always located near a dwelling unit.

Great Falls disposes of its wastes by a landfill operation in which wastes received at the site are covered with earth by the end of each working day. The remaining 13 communities utilize open dumps; at one of these, the wastes are intermittently covered with earth. Although the vector, odor, and fire problems at these open dumps are of little concern during the winter months, the heavy winter snow and melting conditions in the spring make many access roads to disposal sites impassable during as much as 6 mo out of the year. In addition, many of the areas in the county have a clay-type soil that becomes very slick when wet, thereby making roads impassable. Problems have resulted because individuals unable to drive their vehicles to a disposal site because of mud or snow have a tendency to dump refuse along the access road or in other unauthorized areas. Further, winds are common during the summer and winter months and dump sites on hill tops or knolls develop a blowing paper problem.

Industrial solid wastes do not present a significant problem in the county. Most of the waste produced is disposed of by the industry.

A countywide refuse collection and disposal system is recommended to solve the existing solid waste problem. This system should be organized and operated by the City-County Health Department. The Revised Codes of the State of Montana should be amended to clarify the existing authority of the Board of Health to operate such a system.

An organized collection system should be instituted to serve concentrated populations in incorporated and unincorporated municipalities. Three separate routings are proposed to provide collection services for these concentrated populations. Once-a-week collection is recommended in all cases except for the Great Falls metropolitan area in which twice-a-week collection is proposed.

The recommended method of solid waste disposal is by sanitary landfills; these landfills would be located at eight different sites in the county. Approximately 3100 acre-ft of landfill volume would be required for solid waste disposal for the next 20 yr.

At present there are more than 5,000 abandoned automobiles and trucks located at unauthorized disposal sites in the county, with another 5,000 located in junkyards. Over 500 old car hulks are placed as riprap along streams and rivers. It is recommended that the Montana Statutes be amended to prohibit the disposal of abandoned automobiles on private land and to provide for licensing and regulating junkyards. Junk automobiles could be most satisfactorily disposed of by burying them at the proposed landfill sites.

PUBLICATION:

THOMAS, DEAN & HOSKINS, INC. Comprehensive study of solid waste disposal in Cascade County, Montana; final report on a solid waste demonstration. Public Health Service Publication No. 2002. Washington, U.S. Government Printing Office, 1970. (In press.)

Shredding of bulky solid wastes

PROJECT TYPE: DEMONSTRATION **GRANT NO. D01-UI-00097**

GRANTEE: CITY OF NEW YORK, DEPARTMENT OF SANITATION, 125 WORTH STREET, NEW YORK,
NEW YORK 10013

PROJECT DIRECTOR: GEORGE J. KUPCHIK, DEPUTY COMMISSIONER (ENGINEERING & PLANNING),
DEPARTMENT OF SANITATION, 125 WORTH STREET, NEW YORK, NEW YORK 10013

ESTIMATED TOTAL PROJECT COST:	**$1,094,250**
GRANTEE'S SHARE:	**$ 364,750**
FEDERAL SHARE:	**$ 729,500 [01]**
(BY YEAR OF PROJECT LIFE)	

DATE PROJECT STARTED: JUNE 1, 1967 **DATE PROJECT ENDS: MAY 31, 1969**

OBJECTIVES: To demonstrate an improved method of solid waste disposal by developing, designing, constructing, and evaluating a 975 ton per day shearing and shredding facility for reducing bulky solid wastes to a manageable size for efficient disposal in waterfront land recovery, sanitary landfill, and in preparation for incineration.

PROCEDURES: A prototype shearing and shredding installation will be built on a city-owned site adjacent to the Greenpoint Marine Transfer Station. This will include a heavy-duty guillotine type shear for presizing oversized bulky wastes, and a heavy-duty rotary swing-hammer type shredder for further size reduction. Each unit is to be capable of handling an average of 45 tons of bulky wastes per hour.

A consulting engineering firm will be employed to design the proposed installation, provide consulting service in connection with receipt of bids and contract award, and supervise construction.

The ability of the equipment to handle as wide a variety of bulky wastes as can be found in the city will be evaluated. These will range from long timber pilings with concrete caps to softer materials such as rolled carpets. Tests will be conducted to determine production rates, and the reliability of the equipment will be evaluated to determine the percentage of downtime and maintenance required. Operating costs will be evaluated by determining power consumption, manpower requirements for routine operation, and other incidental handling costs concerned with feeding wastes to the equipment, operating the equipment, and discharging the shredded refuse. These evaluations will involve the Department of Sanitation's engineering staff and a consulting engineering firm, which will be retained for this specific purpose.

Disposal of the shredded material will initially be by sanitary landfill. The feasibility of burning the shreddings to generate power for operating the equipment will be evaluated by the city following the above equipment evaluation study.

PROGRESS TO DATE: Preliminary plans, specifications, and total cost estimates for the facility have been prepared by the J. G. White Engineering Corporation, New York City. The proposed facility includes a shear, shredder, and series of pivoting conveyors and cranes to permit a variety of interchanges between barges, trucks, and the processing equipment.

Final contract documents will be submitted by March 1969 and the construction contract awarded during May 1969.

Dairy manure management methods

PROJECT TYPE: DEMONSTRATION GRANT NO. D01-UI-00108
GRANTEE: WASHINGTON STATE UNIVERSITY
PROJECT DIRECTOR: DONALD E. PROCTOR, ASSOCIATE SANITARY ENGINEER, SANITARY ENGINEERING SECTION, COLLEGE OF ENGINEERING RESEARCH DIVISION, WASHINGTON STATE UNIVERSITY, PULLMAN, WASHINGTON 99163

ESTIMATED TOTAL PROJECT COST:	$466,759
GRANTEE'S SHARE:	$102,253
FEDERAL SHARE:	$210,127 [01]
(BY YEAR OF PROJECT LIFE)	$ 75,814 [02]
	$ 78,565 [03]

DATE PROJECT STARTED: JUNE 1, 1967 DATE PROJECT ENDS: AUG. 31, 1970

OBJECTIVES: (1) To demonstrate the advantages of properly scheduled applications of dairy manure to farm lands in areas having seasonally high rainfall and land runoff problems; (2) to demonstrate the use of properly constructed and operated anaerobic lagoons as a feasible method of low-cost storage of dairy manure during seasons unfavorable for land disposal; (3) to compare the relative economic and aesthetic advantages of a water transport system versus a dry system for the collection and disposal of manure; (4) to demonstrate improvements attainable in manure management by providing total roof coverage of confinement areas; and (5) to evaluate the feasibility of employing lagoon treatment for dairies without sufficient land for solids disposal.

PROCEDURES: The study is being conducted by a staff consisting of members of the various departments of Washington State University. Site of the study is the State Reformatory Honor Farm at Monroe, Washington.

Dairy manure management and disposal will be accomplished in several ways for comparison and demonstration purposes, but most emphasis will be placed upon a hydraulic cleaning and lagoon operation method with ultimate disposal on crop lands. A relatively small amount of manure from the dairy herd will be scraped from concrete yards and spread by tank truck and conventional spreaders on farm land. Another small portion will be flushed from the concrete yards and immediately distributed on test plots by a pipe and nozzle system during all seasons of the year.

Most of the manure will be hydraulically flushed into one of two strategically located manure slurry collection sumps and then pumped to a central slurry sump. Here the slurry will be homogenized, sampled, and its volume will be determined. Predetermined volumes of the slurry will be pumped as desired to one of three anaerobic lagoons, to truck mounted spreader tanks, or through fixed and portable pipes to spreading nozzles for distribution.

For long-term operation at each of three lagoon loading intensities (300, 600, and 800 cu ft per cow), the effect of loading intensity upon solids destruction; nondegradable solids accumulation; fate of nutrients; supernatant quality characteristics; and fly, odor, or appearance characteristics will be demonstrated.

In some instances, the anaerobic lagoon supernatant could be disposed of by spray distribution on hay or other cropland. During the wetter season, however, this could easily result in runoff and pollution problems. Part of this supernatant will be distributed on small test plots during all seasons for demonstration and evaluation. During the wetter seasons, the remainder of the supernatant will be treated aerobically in a system patterned after the activated sludge process.

The samples of raw manure slurry from the central manure slurry sump, samples of all lagoon effluents, and samples of the aerobic process effluent will be collected daily. Total solids, volatile solids, ash, chlorides, ammonia nitrogen, organic nitrogen, pH, and chemical oxygen demand (COD) will be determined daily for these samples. Volumetrically weighted samples will be composited and frozen for weekly determinations of phosphorous, volatile acids, alkalinity and biochemical oxygen demand (BOD). With the use of these data, a materials balance will be maintained on each lagoon for total solids, volatile solids, ash, chlorides, nitrogen, phosphorus, COD, and BOD. The ash and chlorides balances will be used to interpret the significance, if any, of exfiltration and dissolved solids losses from the lagoons.

At approximately monthly intervals, three or more undisturbed stratified sample columns will be collected in each lagoon. These will be sampled at 1-ft increments in level to determine the amount of each material remaining in each lagoon. These data, coupled with the running materials accounting for the feed and effluent, will allow evaluation of the amount and rate of solids degradation within the lagoons. It will also allow evaluation of the nutrient losses, if any, that occur.

Probably not less than 50 to 70 percent of the manure solids added to the lagoon during the course of a year will remain as nondegraded solids at the end of the year. A very significant fraction of these solids will be in the floating surface crust. When it becomes necessary to totally remove, or perhaps only reduce, the accumulated solids residue, the mixing-pumping unit will be adjusted to break up and homogenize the crust and bottom deposits. All, or a portion, of the lagoon contents would then be pumped back to the central manure slurry sump. From there this residual slurry would be repumped to croplands for ultimate disposal. This lagoon emptying operation would only be scheduled during the summer months when it is least likely that heavy rains could lead to runoff and stream pollution. This would also be the period of rapid plant growth so the fertilizer values would be utilized more rapidly. The summer soil temperatures will promote rapid incorporation and stabilization of the biologically resistant organic matter in the slurry removed from the lagoon.

A record will be maintained of the amount, time, and method of manure application to all plots of land. Rainfall will be gauged and recorded. To the extent possible, the volume and quality of surface runoff will be determined for all plots. Well points will be driven in each test plot to sample groundwater. Soil profiles and characteristics will be determined in each test plot. The crop productivity of each different plot will be observed and recorded. An attempt will be made to evaluate the effect of each variation of the manure application methods in terms of pollution potential and fertilizer values realized.

To evaluate the feasibility of employing lagoon treatment for dairies without sufficient land for solids disposal, the draining and dewatering characteristics of the accumulated residual crust and sludge in the lagoons will be observed. Both undisturbed and homogenized lagoon samples will be removed and allowed to drain on screen-bottomed test trays. After short-term draining, the cake will be pressed for further reduction of moisture, weight, and volume. The character and amount of this solids residue would be estimated to determine the feasibility of trucking such material to satisfactory disposal sites. The press liquor strength will be determined to estimate the amount and degree of treatment that might be needed before, or subsequent to, discharge to municipal sewerage systems.

PROGRESS TO DATE: The general requirements for facilities needed to accomplish project objectives were carefully reviewed. Four major areas of facilities design were established: (1) the cattle housing facility with provision for manure cleaning or collection; (2) the manure transport, sampling, storage, and treatment facilities; (3) the manure-slurry field-distribution system; and (4) the laboratory-office building. Substantial progress has been made in the construction of these facilities, although some delays have been encountered because of extremely wet weather, flooding, and slowness in equipment delivery.

Plans were developed for obtaining background information on the milk production, milk quality, and health level of the cows housed in the existing confinement facilities. Several different series of tests have been completed. Tests are underway to evaluate the effect of improved sanitation and reduced environmental stress upon mastitis and production data. As more pens are completed, further tests will be undertaken to evaluate the effectiveness of different cleaning techniques.

Some experimental work has been done to develop hydraulic methods for cleaning or removing manure from the specially designed cattle pens. This work appears most promising both in terms of effectiveness and economy. Currently, it is believed that a very high-pressure, mobile spray boom will be capable of removing all manure from one of the large pens in a matter of 2 to 5 min. Hydraulic cleaning will provide a much cleaner living environment for cows, eliminate the rapid erosion of the floor slabs that occurs with blade-type manure scrapers, and accomplish cleaning at greatly reduced costs when compared with conventional methods.

A 10-acre section of the farm has been subdivided into over 200 test plots. These plots are being operated to evaluate the agronomic or fertilizer significance of various manure applications to various crops.

Operational studies on the storage and treatment of manure have been delayed because the necessary facilities are not yet complete. Plans for study of costs and effectiveness of the facilities will be initiated as rapidly as possible when the facilities are completed.

PUBLICATIONS:

PROCTOR, D. E. Management principles application to the disposal of manure to prevent pollution. Presented at the Eighth Texas Industrial Water and Wastewater Conference, Lubbock, Texas, June 6, 1968.

PROCTOR, D. E. The management and disposal of dairy manure. A paper presented at the Purdue Industrial Waste Conference, Purdue University, Lafayette, Indiana, May 8, 1968.

FLAHERTY, D. C. The cows in the suburbs. *Quest*, 6 (1); Mar. 1968. A quarterly publication by the College of Engineering, Washington State University, Pullman, Washington.

Demonstration of improved incinerator technology for a small community

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PROJECT TYPE: DEMONSTRATION **GRANT NO. D01-UI-00106**

GRANTEE: SHIPPENSBURG SANITARY AUTHORITY, P. O. BOX 129, SHIPPENSBURG, PENNSYLVANIA 17257

PROJECT DIRECTOR: WALTER K. SMITH, BOROUGH MANAGER, BOROUGH OF SHIPPENSBURG,
P. O. BOX 129, SHIPPENSBURG, PENNSYLVANIA 17257

ESTIMATED TOTAL PROJECT COST:	**$500,318**
GRANTEE'S SHARE:	**$166,773**
FEDERAL SHARE:	**$306,745 [01]**
(BY YEAR OF PROJECT LIFE)	**$ 13,400 [02]**
	$ 13,400 [03]

DATE PROJECT STARTED: JUNE 1, 1967 **DATE PROJECT ENDS: MAY 31, 1971**

OBJECTIVES: To demonstrate that a small, mechanically stoked, rotary-grate incinerator can provide a small municipal area with a feasible means for solid waste disposal that will meet air pollution standards, eliminate environmental health hazards, and be the most economical method of disposal in an area where sanitary landfill methods cannot be adopted.

PROCEDURES: Consulting engineering services in connection with the design and construction of the incinerator are being provided by the firm of Arrowood, Incorporated, Chambersburg, Pennsylvania.

A stainless-steel, perforated, rotary-grate incinerator, consisting of two units, will be constructed; each of the two units will be capable of handling 36 tons per 24 hr. This facility will be used to dispose of combustible solid wastes from about 12,500 people in the service area around Shippensburg.

Records of incinerator operation will be kept to evaluate the performance and feasibility of this type of installation. These will include such items as the amount and characteristics of refuse received, amount of residue produced, time required to incinerate an average load of refuse, capital and operating costs, and any difficulties or problems of operation.

PROGRESS TO DATE: Construction of the incinerator was completed and shakedown operation begun in November 1968. The facility will be dedicated in January 1969 and then placed in full operation.

Study of integrated disposal of liquid and solid wastes

PROJECT TYPE: STUDY AND INVESTIGATION GRANT NO. D01-UI-00108
GRANTEE: CITY OF PORTLAND
PROJECT DIRECTOR: GEORGE C. CAPELLE, JR., CHIEF ENGINEER, DEPARTMENT OF PUBLIC WORKS,
404 CITY HALL, PORTLAND, MAINE 04111

ESTIMATED TOTAL PROJECT COST:	$76,500
GRANTEE'S SHARE:	$25,500
FEDERAL SHARE:	$51,000 [01]
(BY YEAR OF PROJECT LIFE)	

DATE PROJECT STARTED: FEB. 1, 1968 DATE PROJECT ENDED: JAN. 31, 1969

OBJECTIVES: To demonstrate how new or improved solid waste management techniques could solve a regional solid waste problem by developing a plan for the satisfactory disposal of solid wastes from the city of Portland that will: (1) provide maximum benefit from the utilization of byproducts and salvage; (2) integrate the disposal of solid and liquid wastes to the greatest practical extent; and (3) provide facilities for the disposal of solid wastes from neighboring communities, should this be mutually advantageous.

PROCEDURES: The project will be conducted by city of Portland personnel and the consulting engineering firm of Metcalf & Eddy, Boston, Massachusetts. Major elements of the study are described below.

1. Population data will be developed for Portland and the Greater Portland region. Data will be developed for all solid wastes generated in the study area including abandoned vehicles, appliances, oversized burnable wastes, special industrial and commercial wastes, and municipal rubbish and garbage. A design quantity figure will be established for each category of solid wastes.

2. The required refuse disposal facility capacity to serve (a) individual municipalities and (b) the entire region will be determined. Preliminary plans and comparative cost estimates will be prepared for each alternative.

3. The market potential for heat and/or power produced by an incineration process will be studied. Considerations will include (a) power generation for internal plant usage or for sale to private customers; (b) seawater desalination to produce salts useful for snow and ice control; (c) production of steam and hot water for internal plant usage or sale to municipal or private customers; and (d) reduction in quantities of exhaust gases to obtain lower total operating costs for air pollution control and mechanical draft equipment.

4. The following alternate methods of handling garbage will be evaluated: (a) separate collection, central grinding with discharge to the sewer system, removal at the sewage treatment plant with normal sewage solids by conventional methods, dewatering, and incineration of the garbage-sewage sludge mixture; and (b) separate or combined collection and incineration with rubbish and trash.

5. Alternate methods of disposal of bulky wastes, both combustible and noncombustible, will be evaluated. Incineration after size reduction (along with rubbish and garbage) or batch incineration in a special furnace (without size reduction) will be considered.

6. The economics and feasibility of conventional continuous-feed incineration versus a high-temperature (3,000 F) incineration process will be studied.

7. The market potential and economic value for salvaged metal and for screened and graded incinerator residue as a road material or fill, will be evaluated.

8. The consultant will provide complete preliminary construction and operating cost estimates for the recommended waste disposal facilities and recommend an administrative plan for the municipalities' sharing of the construction and operating costs.

PROGRESS TO DATE: The economics of regional solid waste disposal has been studied by the consulting engineer. A regional disposal plan using incineration would not appear to provide economical solid waste disposal for outlying towns around the Portland area. The cost of regional incineration for the inner circle of municipalities around Portland is more than the cost of sanitary landfill, but there are indications that some of these inner circle towns and cities would find it to their advantage to participate in the use of a regional incinerator located in Portland.

Based upon the concept of regional participation, the consulting engineer is involved in researching, studying, and developing the mechanical aspects of a facility. Two types of incinerators are being considered, conventional and high temperature, with the possibility of producing power and/or producing salt from salt water.

Maximum utilization of sanitary landfills through integrated regional planning

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PROJECT TYPE: STUDY AND INVESTIGATION **GRANT NO.** D01-UI-00113
GRANTEE: COUNTY OF ORANGE, ADMINISTRATION BUILDING, 515 N. SYCAMORE STREET,
SANTA ANA, CALIFORNIA 92701
PROJECT DIRECTOR: A. S. KOCH, ROAD COMMISSIONER AND COUNTY SURVEYOR, 400 W. 8TH STREET,
SANTA ANA, CALIFORNIA 92701

ESTIMATED TOTAL PROJECT COST:	$120,054
GRANTEE'S SHARE:	$ 40,018
FEDERAL SHARE:	$ 40,018 [01]
(BY YEAR OF PROJECT LIFE)	$ 40,018 [02]

DATE PROJECT STARTED: FEB. 1, 1968 **DATE PROJECT ENDS:** JAN. 31, 1970

OBJECTIVES: (1) To develop a unique, long-term, regional solid waste disposal program involving novel concepts for the reuse of sanitary landfill sites to obtain the maximum efficiency of use and reuse of publicly owned lands and minimize overall costs of sanitary landfill operations. (2) To develop a prototype interagency planning program to integrate all governmental planning functions (highways, schools, flood control, water quality control, air pollution control, parks, recreation, refuse disposal, etc.). This type of planning program will provide useful procedures and policies that will aid in securing the public's acceptance of regional solid waste management programs. (3) To develop a "model" ordinance which will provide the means for implementing the regional solid waste disposal program developed from the interagency planning program noted in (1) and (2) above.

PROCEDURES: The study is being conducted by the Orange County Road Department, which is responsible for the administration and operation of the county's refuse disposal program. Consulting engineering services are being furnished by Engineering-Science, Inc., Arcadia, California. The study area will be Orange County. Consideration will be given to including areas outside the county should they be determined to logically affect the study.

A technical advisory committee of representatives from various county agencies will be established to guide and review the work, assure coordination between agencies, and assist in a public relations program. Basic data relative to both current and estimated future generation of solid wastes in the study area will be developed. Municipal, commercial, agricultural, and industrial wastes, as well as any special wastes, will be considered. Information concerning existing solid waste collection and disposal systems in the study area will be developed. Policies and concepts of the State's solid waste program and those of adjacent counties will be investigated for possible effects on implementation of the Orange County plan. Existing and potential future land use and zoning will be determined. Technical criteria for sanitary landfill construction will be established.

An interagency planning committee, comprised of private citizens and representatives of the county agencies, will be formed to formulate and implement definitive planning measures. This committee will develop land utilization concepts for completed sanitary landfills, which can be integrated with the programs of the various county agencies.

Following evaluation of these concepts, potential sanitary landfill sites will be selected to provide adequate solid waste disposal capacity for the county until the year 2010. Plans will be developed for a system of transfer stations. A solid waste management program for the entire county will then be finalized. The benefits of planning for solid waste disposal in this manner (i.e., on an integrated regional basis) will be evaluated in comparison with other alternative planning methods. A model ordinance will be developed requiring that sanitary landfills be considered on a regional planning basis and enabling the establishment of a regional agency to plan and implement such a program. Landfill reuse concepts and provisions of the model ordinance will be generalized to emphasize fundamental planning considerations and criteria developed so that the results of this study will be of maximum use in other areas.

Demonstration of disposal of waste wood and bulky burnable objects by a large city

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PROJECT TYPE: DEMONSTRATION GRANT NO. D01-UI-00115
GRANTEE: CITY OF ST. LOUIS, CITY HALL, ST. LOUIS, MISSOURI 63103
PROJECT DIRECTOR: G. WAYNE SUTTERFIELD, COMMISSIONER OF REFUSE, COLLECTION AND DISPOSAL,
4100 SOUTH FIRST STREET, ST. LOUIS, MISSOURI 63118
ESTIMATED TOTAL PROJECT COST: $397,500
GRANTEE'S SHARE: $152,500
FEDERAL SHARE: $207,000 [01]
(BY YEAR OF PROJECT LIFE) $ 29,000 [02]
$ 29,000 [03]
DATE PROJECT STARTED: APR. 1, 1968 DATE PROJECT ENDS: MAR. 31, 1970

OBJECTIVES: To demonstrate the feasibility of a major city (1) salvaging wood wastes by preparing them for use as pulp wood, and (2) effecting size reduction of bulky burnable wastes for incineration at a site not adjacent to the incinerator.

PROCEDURES: The St. Louis Department of Streets will carry out the project with the cooperation of the Department of Parks and Recreation (whose personnel will supervise field operations concerned with forestry) and the Department of Welfare (whose personnel will supervise operations at the City Workhouse, the site of the demonstration). An engineering consultant will be selected to design the required facilities and to provide other consulting engineering services.

All waste delivered to the site will be weighed, and appropriate records will be maintained of the weight, source, type of material, and other significant items. Waste wood will be sorted into the following categories: (1) wood that can be sold with no further processing; (2) wood that requires cutting or splitting to become suitable for sale; and (3) wood that is not suitable for sale and that would be chipped and used as mulch, landfilled, or possibly incinerated.

Salvable waste wood will be processed and picked up by a local pulpwood dealer. Bulky burnable objects will be reduced in size by a hammermill and transported to a municipal incinerator approximately 2 miles away. All materials that cannot be salvaged or incinerated will be placed in a local sanitary landfill. Records will be kept of all materials leaving the processing area.

PROGRESS TO DATE: The engineering firm of Horner & Shifrin, Inc., St. Louis, Missouri, has been retained to provide the necessary consulting engineering services for the project.

Various items of equipment have been purchased, including a hammermill, electrical equipment, and conveyors to move the wastes to and from the mill. Delivery of the hammermill and associated equipment is scheduled for March 1969. Specifications have been prepared for installation of the equipment, when received.

The project has been delayed so that it is now approximately 6 mo behind schedule. The grantee is expected to request a corresponding time extension for the life of the project.

Disposal of wood and bark wastes by incineration or alternative methods

PROJECT TYPE: STUDY AND INVESTIGATION GRANT NO. D01–UI–00119
GRANTEE: FOREST RESEARCH LABORATORY, OREGON STATE UNIVERSITY
PROJECT DIRECTOR: STANLEY E. CORDER, MECHANICAL ENGINEER, FOREST RESEARCH LABORATORY,
OREGON STATE UNIVERSITY, P. O. BOX 571, CORVALLIS, OREGON 97330
ESTIMATED TOTAL PROJECT COST: $75,000
GRANTEE'S SHARE: $25,000
FEDERAL SHARE: $50,000 [01]
(BY YEAR OF PROJECT LIFE)
DATE PROJECT STARTED: FEB. 1, 1968 DATE PROJECT ENDS: JAN 31, 1969

OBJECTIVE: To determine the feasibility of new or improved solid waste disposal techniques by investigating and evaluating various utilization and disposal methods for wood and bark wastes.

PROCEDURES: The project is being conducted by staff of the Forest Research Laboratory. A survey will be made of both domestic and foreign literature related to wigwam burners, incineration, combustion of wood and bark fuels, current disposal practices, and problems will be obtained by field visits to existing facilities and by consultation with State solid waste program personnel, equipment manufacturers, and others working the this field. Based on information obtained, several methods of wood and bark waste utilization and disposal will be selected for intensive study. Engineering and economic analyses of the most promising methods will be made by appropriate consultants, and recommendations for the demonstration of such methods will be developed.

PROGRESS TO DATE:

Disposal alternatives under study are:

(1) improved incineration in wigwam burners,
(2) incineration in other types of incinerators, and,
(3) disposal in landfills.

Utilization possibilities being evaluated are:

(1) expanded use of residues as fuel for heat and power;
(2) increased use of wood and bark on the soil for amendments, mulch, or for landscaping, and
(3) extraction of wax and certain chemicals from Douglas fir bark.

Field investigations and preliminary studies have been completed. Progress reports have been prepared on the following subjects: disposal of wood wastes by landfill; economics of extracting wax from bark; use of wood residue for pulp and composition board; cost of transporting wood mill residues; removal of particulate matter from wigwam burner emissions; particulate sampling of conical burners; control of wigwam burner combustion. An extensive bibliography of selected references has been prepared covering various factors and methods involved with wood waste disposal and utilization. A survey of many wigwam burners throughout the Pacific Northwest and the South was carried out.

Consultants who have been employed on the project are the firms of Cornell, Howland, Hayes and Merryfield, Corvallis, Oregon; Garretson, Elmendorf, Klein and Reibin, San Francisco, California; and John W. Anderson, Chemical Engineer. The consultants have been called upon for various specific specialized purposes, among which have been: the provision of cost estimates for various modifications designed to improve combustion in wigwam burners; conduct of a national survey of markets for wood residues for soil application; and updating of an earlier economic feasibility study of the extraction of wax and other useful materials from Douglas fir bark.

Some preliminary conclusions reported by the grantee are as follows:

1. A large part of the residues from forest products industries is now being used. Some mills find profitable uses for all their residues. There still remain, however, significant quantities of residues that are disposed of in wagwam burners. Operation of wigwam burners frequently results in air pollution. The problem of air pollution from wigwam burners is urgent, and public pressure bears on industry and control agencies to do something about it. Therefore, work toward an immediate solution to the problem is of top priority. Immediate solutions appear to be of the "burn it or bury it" type.

2. Cost of disposal by landfill will be greater than that by wigwam burner.

3. The largest and most important use of wood residues is in manufacture of paper and composition board, and expansion of this use will continue. The second largest use of wood and bark residues is as fuel. Use for fuel is not likely to expand greatly, but increase in wood utilization will result in greater use of bark as fuel.

4. Use of wood and bark residues as soil additives is increasing, and this market is expected to significantly increase.

5. Chemical extractives could be the basis for a new forest products industry.

To determine the feasibility of shredding, mixing, and compacting a full range of municipal solid wastes for reclaiming submerged lands

PROJECT TYPE: STUDY AND INVESTIGATION **GRANT NO. D01-UI-00121**
GRANTEE: CITY OF CLEVELAND, DEPARTMENT OF PUBLIC SERVICE, ROOM 227, CITY HALL,
CLEVELAND, OHIO 44114
PROJECT DIRECTOR: ERHARDT KUNDE, CHIEF OF LABORATORIES, DEPARTMENT OF HEALTH AND
WELFARE, ROOM 16, CITY HALL, CLEVELAND, OHIO 44114

ESTIMATED TOTAL PROJECT COST:	$150,000
GRANTEE'S SHARE:	$ 50,000
FEDERAL SHARE:	$100,000 (01)
(BY YEAR OF PROJECT LIFE)	

DATE PROJECT STARTED: JUNE 1, 1968 **DATE PROJECT ENDS:** MAY 31, 1969

OBJECTIVES: To investigate the feasibility of combining shredded municipal solid wastes with fly ash, dewatered sewage sludge, river and lake dredgings, and incinerator burnout to produce a dense, compacted sanitary mass suitable for use as fill in the reclamation of submerged lands.

PROCEDURES: All technical aspects of the study are being carried out by Crobaugh Laboratories, Cleveland, Ohio. Bacteriological determinations are being made by the Cleveland Department of Health. Enteroviral determinations are being performed by the Virology Laboratory of Metropolitan General Hospital.

A test facility will be constructed at Crobaugh Laboratories where the project will be conducted. This facility will be larger than laboratory scale, but smaller than pilot plant size. Previous laboratory work has provided basic information concerning the optimum mix of waste and binder materials, but further work will be done. The waste materials and binder will be compressed into compacts for the study. Generally, these will be in the form of 9- by 4- by 3-in. bricks; however, it will be attempted to make at least two or three large compacts approximately 2 to 3 ft long by 1 to 1½ ft deep and wide. Changes in composition of the compacts will be documented, as well as strength and integrity of compacts made from differing mixes.

Pollutional effects of these compacts on the environment in which they are to be placed (Lake Erie) will be investigated. A small laboratory tank will be loaded with prepared compacts and lake water circulated through it. From time to time, samples of the circulating water will be withdrawn for chemical, bacteriological and viral analyses. The tank will be covered so that air samples can also be collected and analyzed for CO_2, CO, O_2, N_2 and hydrocarbons. Anticipated pollutional effects of reclaiming submerged lands by use of compacts as a fill material will be projected. Project findings will be used to develop criteria for appropriate modifications of Cleveland's present solid waste disposal system.

PROGRESS TO DATE: The test facility has been constructed. Compacts have been formed and loaded into a large plastic tank through which lake water is being circulated and from which water and air samples are being collected.

Integrated study of refuse disposal—Madison, St. Clair, and Monroe Counties, Illinois

PROJECT TYPE: STUDY AND INVESTIGATION GRANT NO. D01-UI-00122
GRANTEE: SOUTHWESTERN ILLINOIS METROPOLITAN AREA PLANNING COMMISSION
PROJECT DIRECTOR: THEODORE H. MIKESELL, EXECUTIVE DIRECTOR, SOUTHWESTERN ILLINOIS METROPOLITAN AREA PLANNING COMMISSION, 121A WEST MAIN STREET, COLLINSVILLE, ILLINOIS 62234
ESTIMATED TOTAL PROJECT COST: $68,540
GRANTEE'S SHARE: $22,850
FEDERAL SHARE: $45,690 [01]
(BY YEAR OF PROJECT LIFE)
DATE PROJECT STARTED: APR. 1, 1968 DATE PROJECT ENDED: JAN. 31, 1969

OBJECTIVES: To demonstrate how new or improved solid waste management techniques could solve a regional solid waste problem by developing alternative programs for solid waste disposal in the three-county study area; in one the study area is considered as a whole, whereas in the other, each county is considered individually.

PROCEDURES: The consulting engineering firm of Horner & Shifrin, St. Louis, Missouri, is conducting the major portion of the study.

Population and land use in the study area will be investigated. Current and expected future amounts of solid wastes generated in the area will be estimated on the basis of population projections, data from significant industries, and truck weighings in significant areas. Information on existing collection and disposal systems will be obtained. The suitability of existing and potential disposal sites will be evaluated for use as sanitary landfill, incineration, salvage or composting operations, or a combination of disposal methods. In addition, the proximity of the sites to centers of solid waste production and to points of disposal of salvable materials, will be evaluated. Consideration will be given to use of transfer stations and to both truck and rail transportation. Overall costs of refuse disposal for those methods most applicable to the study area will be estimated.

Industrial interest in salvable materials will be explored, and an attempt will be made to determine specifications for acceptable materials and the extent of the probable market.

PROGRESS TO DATE: Population projection of the three counties within the study area were developed on the basis of individual consideration of each census tract used for the 1960 census. The projections are summarized as follows:

	1960	*1968*	*1990*
Madison County	224,689	270,600	407,600
St. Clair County	262,509	283,100	396,400
Monroe County	15,507	20,400	36,800
	502,705	574,100	840,800

Portable scales were purchased to perform truck weighings for the four more significant areas within the study area, each of which represents an identifiable concentration of population: (1) the Alton-Wood River area, in Madison County; (2) the Granite City-Edwardsville area, in Madison County; (3) the Belleville area, in St. Clair County; and (4) the East St. Louis area, in St. Clair County. The portable scales have been installed at landfill sites that presently receive mixed refuse from the principal communities of the first three areas. Proceedings are now underway to establish a new landfill site that will receive refuse from the fourth area. The site now used for the disposal of refuse from the fourth area is operated under conditions that would not permit the accumulation of meaningful data, and the present site will be abandoned when the new site is in operation. Permission already has been obtained to install the scale at the new site when the site is operable.

The truck weighings performed to date have been found to have certain limitations. Most of the data obtained were quite accurate when evaluated only for the specific site at which the scale was installed. The greatest deficiencies from such limited evaluations were potential inaccuracies concerning (1) the specific source of refuse, since the field men necessarily had to rely on the statements of the truck drivers, and (2) the kind of refuse, which often could not be visually determined as a check upon the truck driver's statements. Further limitations were found in attempting to evaluate the results of the truck weighings with probable total refuse production for the tributary area. No control is exercised over collection districts and points of disposal for the many independent refuse haulers throughout the three-county area. As a result, many of the haulers do not dispose of the refuse at the point nearest its origin, since differences in dumping fees, attitude of the landfill operators, and other factors apparently cause these haulers to follow somewhat erratic disposal patterns. For example, certain haulers dispose of refuse at sites 15 to 20 miles distant from the points of origin, when other sites are available within 4 to 5 miles.

An inventory of present collection and disposal practices has been essentially completed. Within the past year, State inspections, supported by inspections by Madison County authorities, have resulted in a number of disposal sites being closed because of unwillingness or inability of the operators to comply with newly established regulations. Further changes in the disposal pattern are anticipated.

To date, only a paper board manufacturer has displayed significant interest in salvage. Further exploration of the possibilities of salvage in this field are intended.

The remaining objectives of the study are being pursued. Data are still being accumulated relating to the projection of refuse quantities. Legal matters relating to permissive legislation on refuse disposal are being followed up as they arise. Overall possibilities of various plans for the disposal of refuse for the three-county area are in the formative stage.

Sanitary landfill and reclamation project

PROJECT TYPE: DEMONSTRATION GRANT NO. D01-UI-00135
GRANTEE: CITY OF BIG SPRING, TEXAS
PROJECT DIRECTOR: ERNEST E. LILLARD, DIRECTOR OF PUBLIC WORKS, P. O. BOX 391,
BIG SPRING, TEXAS 79720

ESTIMATED TOTAL PROJECT COST:	$144,039
GRANTEE'S SHARE:	$ 48,213
FEDERAL SHARE:	$ 35,481 [01]
(BY YEAR OF PROJECT LIFE)	$ 29,971 [02]
	$ 30,374 [03]

DATE PROJECT STARTED: JAN. 1, 1968 DATE PROJECT ENDS: DEC. 31, 1970

OBJECTIVES: To demonstrate that an improved method of solid waste disposal (sanitary landfill) can reclaim eroded land for agricultural purposes, prevent further erosion damage to an interstate highway and productive land, and successfully implement an effective soil erosion control program.

PROCEDURES: The project will be conducted by city personnel, with the advice and assistance of the U.S. Soil Conservation Service. A badly eroded area near the city has been chosen as the demonstration site. Drainage ways will be rerouted into specially prepared courses designed by the Soil Conservation Service and, thus, relieve the existing gulleys from the drainage function. This work will be completed before landfill operations begin in the area to be reclaimed. Landfill operations will continue until the area has been adequately filled, at which time it will be sodded and seeded in accordance with the plan prepared by the Soil Conservation Service to prevent recurrence of erosion damage. Records will be kept of the weights and volumes of all solid wastes deposited in the landfill. Routine surveys will be made to determine the volume of compacted refuse and cover material. Detailed cost records will be kept. The original and final condition of the area will be documented.

PROGRESS TO DATE: Site preparation and landfill operations are progressing as planned. 'A fence with a gate has been installed so regular opening and closing hour can be observed. A drainage way has been cleared and planted with grass to prevent erosion when the site is placed in service. Also, a gravel access road has been completed. A set of truck scales with a 50,000-lb capacity has been installed, and a scale house has been built. Each vehicle bringing wastes to the site is weighed, and records are maintained of the weight of wastes being placed.

The present gully site is nearing completion, and operations are scheduled to move further downhill approximately Feb. 1, 1969. Cross sections were taken before the project started, and periodic sections are being taken as the sanitary landfill operation continues. During the first 6 mo of operation, a total of 7,029 tons of solid wastes were placed in the landfill.

Systems study analysis of the container-train method of solid waste collection and disposal

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PROJECT TYPE: STUDY AND INVESTIGATION GRANT NO. D01-UI-00135
GRANTEE: CITY OF WICHITA FALLS
PROJECT DIRECTOR: JOHN J. ROARK, DIRECTOR OF PUBLIC WORKS, CITY OF WICHITA FALLS,
P. O. BOX 1431, WICHITA FALLS, TEXAS 76307

ESTIMATED TOTAL PROJECT COST:	$270,005
GRANTEE'S SHARE:	$ 90,002
FEDERAL SHARE:	$ 68,530 [01]
(BY YEAR OF PROJECT LIFE)	$ 69,070 [02]
	$ 42,403 [03]

DATE PROJECT STARTED: FEB. 1, 1968 DATE PROJECT ENDS: JAN. 31, 1971

OBJECTIVES: To determine how solid waste disposal services of a city could be improved by developing a comprehensive management model of a solid waste collection and disposal system utilizing the container-train system of collection.

PROCEDURES: Design of the studies, overall project management, and systems analysis and model development studies are being carried out by the consulting firm of Pinnell and Associates, College Station, Texas.

Data correlating generation rates of commercial, industrial, and municipal wastes with land use will be developed. The annual fluctuation of solid waste generation will be determined. A detailed comparison of the existing packer collection system and the container-train system will be made. This will include documentation and evaluation of the economic, time, and motion requirements; safety; reliability and productivity; aesthetics and public appeal; health aspects; and overall effectiveness of both systems. Optimization studies will be conducted to furnish information on how the collection operation should be performed to maximize the efficiency of the container-train system and minimize operational costs.

These studies will consider routing of the trains, scheduling of the "mother" trucks, and various other operational aspects of the collection procedure. The Wichita Falls Urban Transport Study will provide a basic transportation network system for this purpose. Results of the above studies will serve as the basis for development of a comprehensive management model to simulate the total operation of collection and disposal by a container-train system.

PROGRESS TO DATE: One of the initial steps was a thorough definition and review of the major activities proposed for the project. This work was summarized by preparation of a PERT chart that shows proposed activities for the 3-yr project period and lists and describes these activities.

A data collection system was designed to provide the necessary information to attain the objectives of the project. Work has begun on the evaluation of this system by processing certain types of data. Procedures have been developed that will permit a thorough cost accounting of all aspects of the solid waste collection system.

Procedures and data collection techniques have been developed that will provide daily information on the solid waste collection operations of the city. Data on personnel, equipment, cost, and weights for the packer truck operation have been collected on a daily basis since October 1968. Procedures have been established for describing the local network of streets and alleys in a manner permitting computer utilization of the network data so that studies of equipment routing may be conducted.

A device has been designed by the city to transmit information directly from the packer truck to an IBM 1800 computer. Delays have been encountered in securing authorization from the FCC for an additional local government radio station for such transmission. This has, in turn, delayed progress on other elements of the project.

Dairy manure collecting and composting study

PROJECT TYPE: STUDY AND INVESTIGATION GRANT NO. D01–UI–00137
GRANTEE: CITY OF CERRITOS, 19400 SO. PIONEER BLVD., CERRITOS, CALIFORNIA 90701
PROJECT DIRECTOR: CHARLES L. SENN, UNIVERSITY OF CALIFORNIA AT LOS ANGELES, SCHOOL OF PUBLIC HEALTH, 405 HILGARD AVENUE, LOS ANGELES, CALIFORNIA 90024
ESTIMATED TOTAL PROJECT COST: $135,000
GRANTEE'S SHARE: $ 45,000
FEDERAL SHARE: $ 90,000 [01]
(BY YEAR OF PROJECT LIFE)
DATE PROJECT STARTED: OCT. 1, 1968 DATE PROJECT ENDS: SEPT. 30, 1969

OBJECTIVES: To develop new and improved methods of solving the severe nuisance and health hazard problems associated with solid wastes resulting from raising and feeding large numbers of dairy cattle on concentrated feed lots and corrals located near residential developments.

PROCEDURES: Possible methods of dairy manure disposal will be reviewed and evaluated. Public health requirements, laws, ordinances, and policies pertaining to dairy operation will be identified. Existing conditions on a wide variety of dairy corrals and feed lots will be studied under both dry-weather and wet-weather conditions. Existing and proposed methods of collecting manure from corral surfaces will be evaluated.

Feasibility of manure composting by individual dairies will be investigated. Probable markets and economics of the composting process will be evaluated. Current composting technology, equipment, practices, and costs will be surveyed. Bench-scale composting tests will be conducted, and the data obtained will be evaluated to determine basic operational parameters. A full-scale project will be designed to demonstrate optimal disposal procedures developed.

A number of organizations are involved in the conduct of the project: Public Health Foundation of Los Angeles County; the Health Departments of Los Angeles and Orange Counties; the California State Department of Public Health; the University of California Agricultural Extension Station; and the Dairymen's Fertilizer Cooperative, Cerritos, California. Aerojet-General Corporation, El Monte, California, is providing consulting engineering services and technical operating supervision.

PROGRESS TO DATE: Since the project began, much time has been devoted to establishing procedures, reviewing the literature and available experience, designing test facilities and procedures, acquiring test equipment, and conferring with the several consultants. Tasks for the large number and wide variety of participants have been developed.

The composting study is being developed at the site of the Dairymen's Fertilizer Cooperative. Six bins, which will be used singly and in combination, have been constructed to evaluate factors such as: optimum turning methods and frequencies, permissible variations in moisture, use of additives as drying agents and to increase carbon, use of composted manure as a drying agent, use of additives claimed to speed composting or to improve product, composting of manure-urine mixtures from all-concrete corrals, and various types of mixing mechanisms and devices.

Initially, composting will be accomplished with a skip loader on a tractor. The paved area around the bins is large enough to enable removing all manure for mixing and then replacing it in the bins. Later, other types of devices for mixing-in-place may be tried.

Various tests will be conducted, as often as needed, to evaluate the results and the product, including temperatures, moisture, chemical constituents, and quality of product. The latter will include germination tests for weed seeds.

Marketing analyses are under way to evaluate existing and potential markets, advisability of adding nutrients, etc. Much valuable information is already available from the extensive experience of the Dairymen's Fertilizer Cooperative and other producers and distributors of "natural" organic fertilizer.

The basic data to be obtained from the tests will aid in establishing the required size of composting unit needed for a given number of cows, the frequency of turning needed to produce a suitable product in minimum time, odor problems, if any, etc. A detailed study of fly breeding experiences and corral characteristics influencing fly production has been initiated. A questionnaire has been developed to obtain from sanitarians, city managers, and other officials the various causes of complaints about the dairies. A proposed public-opinion sampling form, which is being reviewed, will be used to obtain data to evaluate the attitudes of people living near dairies.

Solid waste disposal by containerization

PROJECT TYPE: STUDY AND INVESTIGATION **GRANT NO. D01-UI-00138**

GRANTEE: HUMBOLDT COUNTY DEPARTMENT OF PUBLIC WORKS

PROJECT DIRECTOR: RICHARD S. TITERA, ASSISTANT DIRECTOR, HUMBOLDT COUNTY DEPARTMENT OF PUBLIC WORKS, 1106 SECOND STREET, EUREKA, CALIFORNIA 95501

ESTIMATED TOTAL PROJECT COST:	**$37,000**
GRANTEE'S SHARE:	**$12,333**
FEDERAL SHARE:	**$24,667 [01]**
(BY YEAR OF PROJECT LIFE)	

DATE PROJECT STARTED: JUNE 1, 1968 **DATE PROJECT ENDS: MAY 31, 1969**

OBJECTIVES: To demonstrate how new or improved solid waste management techniques could solve a regional solid waste problem by investigating the feasibility of establishing a countywide refuse disposal system for small isolated communities and rural areas using portable containers for waste storage and transfer to centralized sanitary landfills.

PROCEDURES: The study is being made by the County Department of Public Works with participation by the California State Department of Public Health, the County Health Department, and the County Planning Department. Assistance is also anticipated from a consultant expert in containerization.

The existing disposal sites and collection services will be evaluated, and the sources and quantities of refuse generated throughout the county determined. A desirable level of service will be determined and defined, and a preliminary conceptual system design will be developed that can achieve the desired service and make it feasible to maintain acceptable conditions at the various sites.

The county will be divided into areas based largely on geographic conditions, existing services, and present and projected refuse generated. One of these areas typifying the rural refuse disposal problem will be selected and various portable systems developed to serve this area. The systems developed for this area can be extended to the other areas of the county. The alternatives will be evaluated and a selection of the best system made. A detailed design of the chosen system will then be made, and a program for implementation of the system will be recommended.

PROGRESS TO DATE: Data on existing conditions have been compiled and projections to 1985 made. Conceptual designs and cost analyses for various systems and types of equipment have been completed, and a system utilizing 40-cu-yd portable containers has been selected for detailed design. The containers would be placed at six sites within the area chosen for initial implementation and would be transported at a minimum frequency of once a week to a central landfill disposal site where they would be emptied and cleaned. Any routine maintenance on the containers would be performed at this central location.

A preliminary draft of the study report has been prepared. Refinement of cost data and additional detailed design of the actual portable sites are being done, and it is anticipated that the final study report including a recommendation for implementing a program will be complete by Apr. 1, 1969.

Treatment and reutilization of solid wastes from water treatment process

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PROJECT TYPE: STUDY AND INVESTIGATION GRANT NO. D01-UI-00142
GRANTEE: VILLAGE OF PARK FOREST, PARK FOREST VILLAGE HALL, 200 FOREST BOULEVARD,
PARK FOREST, ILLINOIS 60466
PROJECT DIRECTOR: E. VEY, ASSISTANT DIRECTOR, MECHANICS RESEARCH DIVISION,
I. I. T. RESEARCH INSTITUTE, 10 WEST 35TH STREET, CHICAGO, ILLINOIS 60616
ESTIMATED TOTAL PROJECT COST: $66,942
GRANTEE'S SHARE: $22,314
FEDERAL SHARE: $44,628 [01]
(BY YEAR OF PROJECT LIFE)
DATE PROJECT STARTED: JUNE 1, 1968 DATE PROJECT ENDS: MAY 31, 1969

OBJECTIVES: To evaluate the feasibility of new or improved methods of solid waste disposal by: (1) investigating possible methods of dewatering limestone sludge on a scale that can be economically applied to the total sludge output from the treatment of the well water supply of the village of Park Forest, Illinois, and other villages with similar problems; (2) determining economically feasible uses for the dewatered sludge.

PROCEDURES: The project is being conducted by the Illinois Institute of Technology Research Institute, Chicago, Illinois.

Sludge samples from the treatment process will be analyzed to determine standard engineering properties such as shrinkage limit, water content, and consolidation characteristics (coefficients of consolidation and compressibility). These measurements will provide a basis for comparison in evaluating the results of the experimental program. Experiments will then be performed to investigate means of accelerating the consolidation process.

Consolidation using electro-osmosis. A direct current potential will be applied across consolidation samples of various thicknesses and cross-sectional areas. Loading will be applied in increments determined on the basis of standard one-dimensional consolidation tests with consideration to the maximum loads feasible in a full-scale application. The effects of different potentials on the consolidation rate will be determined, and the desirability of changing the electrolyte concentration in the sludge will be evaluated.

Three-dimensional consolidation. Experiments will be performed on cylindrical and rectangular portions of various sized samples wherein filters are provided on all surfaces. This will involve the design of filters to determine the most efficient filter from the standpoint of economical usage on a large scale and efficiency of drainage during consolidation. The effects of the different filters and geometries on consolidation rates will be determined.

Combinations of above methods. Experiments will be performed on samples wherein electro-osmosis is used and three dimensional drainage is permitted. Relative merits of each technique will be determined from the standpoint of power consumption and economical utilization on a large scale.

The feasibility of applying these techniques in full-scale use will be investigated. Consideration will be given to anticipated design problems.

Methods of utilizing the dewatered sludge will be investigated. Utilization as an additive to improve the properties of soils used in base course under pavements and in embankments appears promising. Experiments will be performed to determine optimum sludge concentrations in such soils.

PROGRESS TO DATE: A literature survey

was made to determine how the other municipalities with a similar water softening process dispose of the sludge. It was found that limestone sludge is disposed of by most municipalities by lagooning. Some cities reclaim lime by recalcining. In Boca Raton, Florida, the sludge is dewatered on a vacuum filter and used by highway contractors and local residents as a soil admixture. This increases the water retention properties of the local sandy soils.

Samples of a glacial clay and an organic clay prevalent in the Park Forest area were obtained. The properties of these soils with various amounts of the water softening sludge are being investigated to determine if the sludge has any beneficial effects.

Plasticity, density, and strength tests were performed on the two soils from Park Forest and on a soil obtained from a field test site at Hazelcrest, Illinois. Tests were also made on the inorganic soils containing various amounts of the water softening sludge.

Information was received from a manufacturer of vacuum filtration equipment. This information contained procedures for simple laboratory tests to determine the feasibility and performance of full-scale equipment. These tests will be performed on the sludge generated at the Park Forest plant.

Demonstration of the use of model sanitary landfilling methods to convert open dump to recreation area

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PROJECT TYPE: DEMONSTRATION GRANT NO. D01–UI–00143
GRANTEE: DEPARTMENT OF SANITARY ENGINEERING, GOVERNMENT OF THE DISTRICT OF COLUMBIA
PROJECT DIRECTOR: ROBERT R. PERRY, DEPUTY CHIEF, DIVISION OF SANITATION, DEPARTMENT OF SANITARY ENGINEERING, GOVERNMENT OF THE DISTRICT OF COLUMBIA, 14TH AND E STREETS, N.W., WASHINGTON, D. C. 20004
ESTIMATED TOTAL PROJECT COST: $1,100,000
GRANTEE'S SHARE: $ 366,667
FEDERAL SHARE: $ 733,333 [01]
(BY YEAR OF PROJECT LIFE)
DATE PROJECT STARTED: DEC. 1, 1967 DATE PROJECT ENDS: APR. 30, 1969

OBJECTIVES: To demonstrate how open dumping and burning of trash can be eliminated and how burning sites and other small tracts of land, within densely populated metropolitan areas, can be reclaimed for recreational use with an improved method of solid waste disposal, such as model sanitary landfill techniques.

PROCEDURES: The District of Columbia discontinued open burning of solid wastes at the Kenilworth site and will convert it to a recreational area through the use of model sanitary landfill methods.

Consulting engineering services are being furnished by the firm of Whitman, Requardt and Associates, Baltimore, Maryland. The consulting firm is responsible for planning and developing specifications for a model sanitary landfill to permit the ultimate development of the site as planned by the National Park Service and the District of Columbia Department of Recreation. The firm will also provide engineering inspection services to ensure that the plans and specifications are followed in detail.

A contract will be entered into for the actual operation of the sanitary landfill with a firm having national recognition and experience in the operation of model sanitary landfills. The sanitary landfill operator will be responsible for obtaining the necessary equipment and for operating the landfill in accordance with the approved engineering specifications.

Lands to be used for the sanitary landfills will be made available by the National Capital Parks. The National Park Service and the District's Department of Recreation will develop the ultimate-use plans, and as the landfilling is completed, the National Park Service will develop the Kenilworth Park site facilities.

PROGRESS TO DATE: Bids for operation of the proposed landfill were received in November 1967. One of the bidders entered a protest with the General Accounting Office concerning the proposed award, and on Jan. 11, 1968, the General Accounting Office advised the District to provide more detailed specifications and readvertise the contract.

The District was preparing to readvertise when, on the night of Feb. 15, 1968, a 7-yr-old child was burned to death at Kenilworth while looking through the refuse for bicycle parts. The following day all burning was stopped at the site and emergency sanitary landfill operations were begun. The District conducted this emergency operation for 6 wk, during which time 38,600 tons of refuse and 23,100 tons of incinerator residue were disposed of at the Kenilworth site. A landfill operation contract was executed on Mar. 5, 1968, and on Apr. 2, the contractor, Curtin & Johnson, Inc. – Landfill, Inc., began landfill operations and the District ceased its emergency operation.

A few days after the contract was awarded, a preliminary cleanup was begun of the area where the contractor was to begin landfilling. A complete rat abatement program, covering the entire site, was carried out by a professional exterminator. Piles of burned or partially burned material were compacted and covered with 6 to 8 in. of earth.

The contractor has used the area method of filling during his entire sanitary landfill operations thus far. Refuse is dumped from the incoming trucks at the bottom of the sloping face and compacted with the compactor dozers as they push the material up the slope. Originally, the area south of Watts Branch was expected to be completed in October or November. Earlier test pits proved misleading, and a considerable fill volume was made available for refuse disposal when earth from previously filled areas and some virgin areas were excavated to the limit. The limit of excavation was either burned residue or groundwater. Where groundwater was encountered, a layer of several feet of earth was placed and compacted before placement of any refuse. This additional fill volume has allowed the landfill operation to continue south of Watts Branch, and the area was not expected to reach final contours until February or March 1969.

From Apr. 2, 1968, to Nov. 30, 1968, the District disposed of 182,000 tons of refuse and 255,000 cu yd of incinerator residue, or a weekly average of 5,200 tons of refuse and 7,300 cu yd of incinerator residue, at Kenilworth. The amount of refuse is 15.3 percent in excess of the amount estimated when the project was developed. This excess was partially caused by the volume of debris requiring disposal following the civil disturbances in Washington during April and the Poor Peoples' March and encampment during the early summer. Noncombustible demolition material was directed to another fill site, but combustible material had to be disposed of at Kenilworth. Despite this additional volume, the Kenilworth site is expected to last until September 1969 because of the additional space available south of Watts Branch.

Costs have been higher than originally anticipated and are now expected to be about $3.30 per ton. This price per ton is based on the total project costs including the purchase of the equipment and the estimated tonnage of refuse and incinerator residue that will be disposed of during the project period. Because of the classification as a "model," a considerable amount of money will have been spent to prepare the area for National Park Service development and the relatively short life of the fill causes these expenditures to have a greater impact on the price per ton. Compared with present District incinerator operation costs of $6.10 per ton, the landfill is still a bargain. A landfill located within a metropolitan area should be expected to be more expensive than one operated at some remote location, but the reduced hauling costs can justify these additional expenditures.

An important aspect of the Kenilworth Model Sanitary Landfill Project was the need to demonstrate this method of refuse disposal to citizens in the Metropolitan Washington area. Not only did the general public need to be convinced that sanitary landfill was a satisfactory method for disposal for solid wastes, but it was also most important that the National Park Service and other federal agencies controlling open lands be convinced. From the beginning, the Kenilworth operation has had an open-door policy for citizens, either in groups or as individuals, and for the news media. There has been an active effort to encourage officials and others to visit the project. By Dec. 1, 1968, 233 persons had visited the site and signed the guest book.

The project to demonstrate the sanitary landfill as a satisfactory method of disposal would seem to have already had positive results for the District of Columbia. The National Park Service, which entered the original Kenilworth agreement as a skeptic, now appears satisfied that such an operation can be carried out in proper locations to benefit both the Park Service and the District. Negotiations are continuing between the District and the Park Service to reach agreement for the utilization of a sanitary landfill at the Oxon Bay site to develop an 18 hole championship golf course. The District is proposing to design the golf course and build the contours with a sanitary landfill operation scheduled to begin when Kenilworth is completed.

PUBLICATION:

DEPARTMENT OF SANITARY ENGINEERING, DISTRICT OF COLUMBIA. Kenilworth model sanitary landfill; interim report on a solid waste demonstration project, December 1967–January 1969. Washington, U.S. Government Printing Office, 1969. (In press.)

Demonstration of modern curricula and techniques in the field of solid waste management

PROJECT TYPE: DEMONSTRATION **GRANT NO.** D01–U1–00145

GRANTEE: CHARLES COUNTY COMMUNITY COLLEGE, LA PLATA, MARYLAND 20646

PROJECT DIRECTOR: BELVA JENSEN, ASSOCIATE PROFESSOR OF BIOLOGY

ESTIMATED TOTAL PROJECT COST:	$136,950
GRANTEE'S SHARE:	$ 45,651
FEDERAL SHARE:	$ 30,433 [01]
(BY YEAR OF PROJECT LIFE)	$ 30,433 [02]
	$ 30,433 [03]

DATE PROJECT STARTED: JUNE 1, 1968 **DATE PROJECT ENDS:** AUG. 31, 1971

OBJECTIVES: To demonstrate a method for training technicians in solid waste management.

PROCEDURES: A 1-yr Technician-grade Curriculum in Solid Wastes Management will be developed to train personnel in the operation of all phases of solid waste collection and disposal methods that might be used by a municipality or region. Courses directly related to solid waste management will cover such topics as collection, incineration, composting, landfill management, vector control, site selection, soil types and characteristics, and community economics. The curriculum will be implemented, and its effectiveness for use at other educational institutions will be evaluated.

A 5-day short course will be established for current solid waste disposal operating personnel to provide demonstrations of proper use of equipment and techniques. Health and safety aspects of the work will be stressed.

Symposia will be established for solid waste management personnel in the greater Washington area to keep them informed of developments on a regional basis in the solid wastes field.

PROGRESS TO DATE: The 1-yr curriculum in solid waste management has been prepared. First semester courses will be introduction to Solid Waste Management and Control, English, Applied Mathematics, Applied Biology, and Solid Waste – Collection and Storage. Second semester subjects are Basic Engineering Concepts, Community Problems and Public Relations, Systems Concept in Solid Waste Management, Solid Waste Disposal, Equipment Operation and Utilization, and Technical Report Writing.

Each semester will involve 16 credit hours allotted to the course work shown. Detailed teaching plans for each course are being completed. Arrangements have been made with the Department of Public Works of Prince Georges County, Maryland, to hold some of the training sessions at their model sanitary landfill.

A short course in solid waste management, designed to give an overall picture of the problems involved and some of the solutions available, was given on Mar. 24 to 28, 1969.

Demonstration of a compact incineration system meeting all antipollution requirements of record in the United States

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PROJECT TYPE: STUDY AND INVESTIGATION **GRANT NO. D01–UI–00155**

GRANTEE: TOWN OF WINDSOR

PROJECT DIRECTOR: ALBERT G. ILG, TOWN MANAGER, TOWN HALL, WINDSOR, CONNECTICUT 06095

ESTIMATED TOTAL PROJECT COST:	**$23,362**
GRANTEE'S SHARE:	**$ 7,787**
FEDERAL SHARE:	**$15,575**
(BY YEAR OF PROJECT LIFE)	

DATE PROJECT STARTED: DEC. 1, 1968 **DATE PROJECT ENDS: NOV. 30, 1969**

OBJECTIVES: To evaluate a small incineration device that offers an improved means of solid waste disposal for small communities.

PROCEDURES: A prototype incineration device located at Combustion Engineering, Inc., Windsor, Connecticut, will be tested and evaluated by Betz Laboratories, Trevose, Pennsylvania, for combustion efficiency and pollution hazards. If it appears from these tests that the device could provide an improved method of solid waste disposal for small communities, plans and specifications for construction of a full-scale demonstration unit for the town will be prepared.

PROGRESS TO DATE: Final arrangements are being made for conduct of the evaluation tests, which are scheduled for January 1969.

Evaluation of air pollution control equipment for small batch-feed municipal incinerator

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PROJECT TYPE: STUDY AND INVESTIGATION **GRANT NO.** D01–UI–00156
GRANTEE: INCORPORATED VILLAGE OF FREEPORT, NEW YORK, 46 N. OCEAN AVE.,
FREEPORT, NEW YORK 11520
PROJECT DIRECTOR: WALTER J. POPE, PARTNER, BALDWIN AND CORNELIUS CO.,
101 S. BERGEN PLACE, FREEPORT, NEW YORK 11520

ESTIMATED TOTAL PROJECT COST:	$101,000
GRANTEE'S SHARE:	$ 33,667
FEDERAL SHARE: (BY YEAR OF PROJECT LIFE)	$ 67,333 [01]

DATE PROJECT STARTED: JUNE 1, 1968 **DATE PROJECT ENDS:** MAY 31, 1969

OBJECTIVES: To determine which of various pilot models of emission control equipment will reduce emissions from a batch-feed incinerator to the level required by air pollution regulations.

PROCEDURES: The study is being conducted by the consulting engineering firm of Baldwin and Cornelius Company, Freeport, with the assistance of E. M. Voelker of the firm of Nash, Cadmus and Voelker as Incinerator Consultant. The firm of Roy F. Weston, Co., West Chester, Pennsylvania, has been retained to conduct the equipment tests to be made.

Pilot models of four wet scrubbers will be tested at various resistance levels. A pilot model of an electrostatic precipitator will also be tested. Data to be collected will include characteristics and weight of refuse burned; water usage; weight of particulate matter entering and leaving the pilot unit, measured with the use of both the Public Health Service low-volume sampling method and the A.S.M.E. PTC 27-1957 high-volume sampling procedure; gas stream velocity and temperatures, and CO, CO_2, and O_2 content of the gas stream entering and leaving the pilot unit. These data will permit evaluation of particulate removal efficiencies at various resistances for several scrubbers, compare the relation of the weight of particulate matter emitted to weight of refuse burned, and compare the relation of weight of particulate collected by the high-volume and the low-volume sampling methods.

PROGRESS TO DATE: The first test sequence was run between Dec. 17 and 20, 1968. A rerun will be necessary because of operating difficulties. A complete series of tests has been scheduled for the early part of 1969.

Regional solid waste study-design and implementation program

PROJECT TYPE: STUDY AND INVESTIGATION **GRANT NO.** D01-UI-00159

GRANTEE: CENTRAL SAVANNAH RIVER AREA PLANNING AND DEVELOPMENT COMMISSION,
650 ELLIS STREET, 2ND FLOOR, AUGUSTA, GEORGIA 30902

PROJECT DIRECTOR: RONALD BONITATIBUS, ENGINEERING CONSULTANT, CENTRAL SAVANNAH RIVER AREA PLANNING AND DEVELOPMENT COMMISSION

ESTIMATED TOTAL PROJECT COST:	$180,000
GRANTEE'S SHARE:	$ 60,000
FEDERAL SHARE:	$ 40,000 [01]
(BY YEAR OF PROJECT LIFE)	$ 40,000 [02]
	$ 40,000 [03]

DATE PROJECT STARTED: JUNE 1, 1968 **DATE PROJECT ENDS:** MAY 31, 1971

OBJECTIVES: To demonstrate that an area commission, by developing and implementing a regional plan for solid waste disposal, can effectively deal with problems of solid waste collection and disposal in the 13-county area served by the commission.

PROCEDURES: The project is being conducted by the commission's staff, with consultative and advisory services provided, as required, by the consulting engineering firm of Black & Veatch, Kansas City, Missouri.

During the first year of the project, the commission's staff, with the cooperation of State and local health officials, will survey the 13-county area to determine the magnitude of the solid wastes problem. Possible methods of solid waste collection and disposal on a regional basis will be studied. Existing ordinances, rules, and regulations relating to solid wastes will be reviewed and needed improvements recommended. A regional solid waste disposal program will be developed for implementation during the last 2 yr of the project.

The commission's staff will work closely with local officials to coordinate their efforts in implementing this plan and will also be available on a consultative basis to provide required assistance in the various phases of solid waste collection, storage, or disposal. An appropriate public relations and education program will be conducted. A training program will be developed for operators of disposal facilities and interested municipal officials.

PROGRESS TO DATE: Each community in the study area was visited, and information regarding solid waste collection and disposal practices was obtained. An onsite investigation and evaluation of existing disposal facilities was conducted during these visits.

There are some 55 communities in the study area, 75 percent of which have populations less than 1,000, and 11 percent of which have populations greater than 3,000. Fourteen of these communities provide at least twice weekly refuse collection. Two other communities provide adequate service to part of the community. A large majority of the remaining communities provide no collection service at all, and a few provide collection once a month or once every 2 wk. In Richmond and Columbia counties, collection is available to individuals on a contract basis with a private contractor. Residents of the other 11 counties must remove their solid wastes on an individual basis.

At present only one small community in the study area is using the sanitary landfill method of solid waste disposal. City dumps, roadside dumps, and private dumps make up the remainder of the disposal facilities for solid waste.

None of the communities have records regarding waste generation. To have a basis of estimating per capita generation, weighing programs have been instituted in several small representative communities. Initial attempts to conduct a weighing program in Augusta and Richmond county were unsuccessful. A report has been submitted to the city and county officials outlining the need for and the use of weighing records. A survey to estimate the volume of solid waste going to both the city and county landfills will be conducted in January 1969.

A model refuse ordinance for use in the study area was written. This covers most of the considerations related to solid waste storage, collection, disposal, and enforcement and will be used as a guide to improve existing ordinances or to establish new ordinances. A form was also prepared for community use in recording their refuse collection and disposal expenses. At present many of the communities are unaware of the actual cost of their refuse programs.

The refuse collection programs for the cities of Augusta and Sylvania were evaluated, and suggestions for improving the operation were made. A similar evaluation, with recommendations, was made for the landfill operation being conducted by Sylvania. A course outline was prepared for the sanitary landfill school to be held in Sylvania in the spring of 1969.

Preliminary consideration of a comprehensive solid waste collection and disposal plan for the study area indicates that the most economical solution would appear to be the establishment of a number of landfills, each of which would serve several communities without requiring excessive hauls. Sites would be operated on a 5-day-per-wk basis, and all expenses would be borne by communities and counties using the site. With the exception of the Richmond county site, the total community population served would range from 5,000 to 15,000.

For communities not having existing collection services and for the rural population, the use of strategically placed bulk-storage containers is proposed, with a collection route designed to provide adequate coverage and pickup of wastes.

A system of this type, operated with the cooperation of residents of the area, is believed to result in controlled sanitary disposal of much of the solid waste of the area. The proposed program, as outlined above, will be presented to some target areas and, hopefully, implemented.

Solid waste disposal program multigovernmental metropolitan area

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PROJECT TYPE: STUDY AND INVESTIGATION GRANT NO. D01-UI-00161
GRANTEE: FOX VALLEY COUNCIL OF GOVERNMENTS, 12TH FLOOR, ZUELKE BUILDING,
APPLETON, WISCONSIN 54911
PROJECT DIRECTOR: EUGENE E. FRANCHETT, EXECUTIVE DIRECTOR, FOX VALLEY COUNCIL
OF GOVERNMENTS

ESTIMATED TOTAL PROJECT:	$38,890
GRANTEE'S SHARE:	$12,963
FEDERAL SHARE:	$25,927 [01]
(BY YEAR OF PROJECT LIFE)	

DATE PROJECT STARTED: JUNE 1, 1968 DATE PROJECT ENDS: MAY 31, 1969

OBJECTIVES: To demonstrate how new and improved solid waste management techniques could solve a regional solid waste problem by developing an administratively acceptable and economically feasible solid waste disposal plan and program capable of serving the present and future needs of a large metropolitan area in the State of Wisconsin.

PROCEDURES: The consulting engineering firm of Donahue and Associates, Sheboygan, Wisconsin, is conducting the study under the general supervision and direction of the Council's Executive Director. The study area consists of approximately 200 sq miles and embraces parts of Calumet, Outagamie, and Winnebago Counties. The cities of Neenah, Menasha, Appleton, and Kaukauna are located in the area.

Data pertaining to existing solid wastes collection systems and disposal facilities in the study area will be assembled, updated, and analyzed. Information concerning topography, geology, soils, land use, and population will also be developed. A tentative area-wide solid waste collection and disposal plan will be prepared and means for its implementation considered. This will include items such as scheduling of construction in accordance with relative need, indication of a financing plan for the proposed facilities, and the coordinative, legislative, and administrative measures required for implementation of the plan.

At various stages of the project, "coordinating conferences" will be held with representatives of Federal, State, and local governments, planning agencies, and private interests concerned with the development of the plan. An initial meeting will be held to explain the project and solicit the cooperation of such groups. The tentative plan, when developed, and means of implementing the plan will be considered at subsequent meetings. The final such meeting will be devoted to a consideration and discussion of the draft of the completed plan. Public support for the completed plan and capital improvements program will be developed by means of public hearings, meetings, and conferences and by a public education program designed to secure general acceptance for the planned improvements.

PROGRESS TO DATE: Meetings have been held with member units of the Council of Governments and with personnel from industrial and commercial facilities in the study area to explain the study and solicit their assistance.

Available information concerning solid wastes in the study area has been collected. Member units of the Council of Governments have provided historical information and operational records pertaining to their solid waste collection and disposal operations. In addition, they have completed weighing programs specifically for the study that provide basic data from which solid waste generation by residential and commercial sources is being estimated. Information concerning industrial solid wastes has been solicited from 29 industries in the study area by means of a questionnaire, and 19 completed questionnaires have been returned.

A study is being made to determine locations in the study area that might be developed as sanitary landfill sites and those areas that could not be so developed.

Economic feasibility and administrative organization required to construct a 1,000-foot solid wastes mountain and recreational area in a major urbanized region

PROJECT TYPE: STUDY AND INVESTIGATION **GRANT NO.** D01–UI–00165

GRANTEE: THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO, 100 EAST ERIE STREET, CHICAGO, ILLINOIS 60611

PROJECT DIRECTOR: FRANK E. DALTON, ACTING CHIEF ENGINEER, THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

ESTIMATED TOTAL PROJECT COST:	$210,000
GRANTEE'S SHARE:	$ 70,000
FEDERAL SHARE: (BY YEAR OF PROJECT LIFE)	$140,000 [01]

DATE PROJECT STARTED: DEC. 1, 1968 **DATE PROJECT ENDS:** NOV. 30, 1969

OBJECTIVES: To evaluate the feasibility of constructing a large "mountain" in an urbanized area, with the use of solid wastes generated in Cook County, and of developing it as a recreational facility for pursuits such as skiing, hiking, picnicking, nature study, tobogganing, skating, and horseback riding.

PROCEDURES: The district will contract with a consulting engineering firm to conduct the study.

A suitable site for the proposed mountain will be selected, and local geological features, prevention of environmental pollution or contamination, and aesthetics will be considered. The most suitable methods for handling the solid wastes generated in Cook County will be determined.

An ultimate recreational facility will be designed and anticipated revenues estimated. The numerous interest groups that would be involved in the undertaking will be identified and their cooperation secured. Estimates will be made of construction and operation costs of the proposed facility, and rate schedules will be developed for disposal of solid wastes at the site. A financing plan will be developed, together with a proposed administrative organization to operate the facility. Any legislation required to implement the plan for the facility will be developed and introduced into the Illinois General Assembly.

PROGRESS TO DATE: Negotiations are underway with a consulting engineering firm.

Solid waste handling and disposal in multistory buildings and hospitals

PROJECT TYPE: STUDY AND INVESTIGATION GRANT NO. D01–UI–00164
GRANTEE: COUNTY OF LOS ANGELES, 500 WEST TEMPLE STREET, LOS ANGELES, CALIFORNIA 90012
PROJECT DIRECTOR: JOHN A. LAMBIE, COUNTY ENGINEER, 108 WEST SECOND STREET,
LOS ANGELES, CALIFORNIA 90012

ESTIMATED TOTAL PROJECT COST:	$260,760
GRANTEE'S SHARE:	$ 89,945
FEDERAL SHARE:	$115,860 [01]
(BY YEAR OF PROJECT LIFE)	$ 54,955 [02]

DATE PROJECT STARTED: JUNE 1, 1968 DATE PROJECT ENDS: MAY 31, 1970

OBJECTIVES: To demonstrate the need for improved and modernized equipment, methods, and practices in refuse collection and disposal at various county buildings and institutions by making an in-depth study and to provide design standards and code requirements that will ensure adequate sanitary facilities in all buildings to be constructed within the county jurisdiction.

PROCEDURES: The project is being conducted by the consulting firm of Engineering Service Corporation and Greenleaf/Telesca, Los Angeles, California. Various special consultants will be used as required.

Types of county buildings to be studied include office buildings, jails, hospitals, and a hospital complex. A coordinating committee, consisting of county personnel concerned with the operation, maintenance, and administration of waste collection and disposal facilities at these buildings, will be established to assist in guiding the studies, evaluating results, and preparing recommendations.

Each building or institution will be surveyed to establish present conditions, both physical and sanitary, quantities and types of refuse produced, and present means of disposal. Deficiencies and needs for improvement in the present methods and systems will be noted and analyzed. Surveys of private multistory and apartment buildings will be made to the extent required to verify the quantities of refuse and similarity of problems as determined by the detailed survey of county facilities.

Investigations will be made of refuse collection, preparation, and handling systems to determine operating characteristics, size and space requirements, and cost of installation and operation. Studies will be made to determine the type of system that might best be employed in each of the types of buildings involved. Consideration will be given to shredding, pulping, and compacting of refuse, and to gravity, pneumatic, vacuum, and containerized handling systems.

Various methods of refuse disposal will be investigated (salvage, grinding into the sewage collection system, sanitary landfill, composting, and incineration), and health hazards, air pollution, reliability, and operating cost will be considered. The method or methods of refuse disposal that might best be employed in each type of building under consideration will be determined.

Preliminary designs and cost estimates will be prepared for installation of a system for the collection and disposal of solid wastes in a hospital building complex and a multistory office building or jail.

PROGRESS TO DATE: Preliminary observations of refuse disposal practices are virtually complete. Weights of refuse from all but one facility have been obtained and tabulated. Planning and scheduling of in-building studies at hospitals are near completion. Results to date confirm that many facilities do not handle refuse efficiently and that crowded and unsanitary conditions exist in trash areas in many buildings.

Numerous articles and brochures concerning refuse handling equipment have been received and are being reviewed. In connection with investigation of various refuse disposal practices, inspections of four hospitals in Florida have been completed.

The project is proceeding essentially on schedule.

Systems planning for regional solid waste management in areas comprising diverse socioeconomic characteristics

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PROJECT TYPE: STUDY AND INVESTIGATION GRANT NO. D01–UI–00168
GRANTEE: CITY OF ALBUQUERQUE
PROJECT DIRECTOR: VICTOR BICKEL, DIRECTOR, DEPARTMENT OF ENVIRONMENTAL HEALTH,
CITY OF ALBUQUERQUE, BOX 1293, ALBUQUERQUE, NEW MEXICO 87103

ESTIMATED TOTAL PROJECT COST:	$98,913
GRANTEE'S SHARE:	$32,971
FEDERAL SHARE:	$65,942 [01]
(BY YEAR OF PROJECT LIFE)	

DATE PROJECT STARTED: APRIL 1, 1968 **DATE PROJECT ENDS:** MAR. 31, 1969

OBJECTIVES: To demonstrate how new or improved solid waste management techniques could solve a regional solid waste problem by developing a long-range plan for the management of solid wastes for a heterogeneous regional area of central New Mexico.

PROCEDURES: The project is being conducted by staff of the city's Department of Environmental Health, with consulting engineering services being provided by the firm of D. F. Molzen and Associates, Inc., Albuquerque, New Mexico; by Engineering-Science, Inc., Arcadia, California; and by Dr. John W. Hernandez, Associate Professor, New Mexico State University.

The study area consists of Metropolitan Albuquerque and populated areas north and south of the city. Political jurisdictions in the area are the cities of Albuquerque, Belen, and Bernalillo; the village of Los Lunas; the counties of Bernalillo, Valencia, and Sandoval; the Isleta; and Sandia Pueblos.

Basic data will be developed regarding the current generation of solid wastes in the study area including agricultural, industrial, municipal, and commercial. Special categories may be used for wastes that create special handling or health problems. Projections of future waste generation will be made. Existing solid waste management systems in the study area will be described and operational costs determined. Ongoing solid waste management programs of the state and related areas will be investigated. Statutes and ordinances that may relate to solid waste management in the study area will be identified. Existing land use and zoning will be determined, and projections made of future land use.

Economic and demographic data will be used to project future employment and population in the study area. Alternate means of financing the proposed program will be developed and an optimal method selected. Physiographic, geologic, meteorologic, and ground water characteristics of the study area will be determined; and a preliminary selection of future landfill sites will be made on the basis of these studies. Various methods of solid waste disposal will be examined and defined in detail.

An advisory committee, comprised of community leaders from each of the political jurisdictions in the study area, will develop an educational/enforcement program for implementation concurrently with the contemplated solid waste management system. This group would also guide the preparation of a suggested ordinance that would be considered for adoption and implementation by all of the political entities in the study area.

Solid waste management systems applicable to the study area will be developed and compiled, and the optimal system selected on the basis of overall effectiveness, total cost, and ability to minimize undesirable effects (noise, aesthetic, traffic interference, etc.) on the environment.

The parameters and fundamental principles forming the basis for selection of the optimal solid waste management system and the method of determining the optimal system of financing will be generalized for utilization by other areas in planning similar systems to meet analogous problems.

PROGRESS TO DATE: Some portions of the study have been completed. The existing solid wastes management systems in the study area have been determined. Information relative to the physiographic, geologic, meteorologic, and ground water characteristics of the study area has been collected.

Population data are being compiled along with information on waste production, financial capabilities, and legal regulations pertinent to solid wastes management systems. Planning of an educational program is under way. Preliminary planning for the establishment of an enforcement program has begun.

A tentative outline has been developed for the final project report.

Development and testing of compaction and baling equipment for rail haul of solid wastes

PROJECT TYPE: STUDY AND INVESTIGATION — GRANT NO. D01-UI-00170
GRANTEE: CITY OF CHICAGO
PROJECT DIRECTOR: JAMES J. MC DONOUGH, ACTING COMMISSIONER, DEPARTMENT OF STREETS AND SANITATION, CITY HALL, CHICAGO, ILLINOIS 60602

ESTIMATED TOTAL PROJECT COST:	$468,000
GRANTEE'S SHARE:	$156,000
FEDERAL SHARE:	$312,000 (01)
(BY YEAR OF PROJECT LIFE)	

DATE PROJECT STARTED: MAY 1, 1968 — DATE PROJECT ENDS: APR. 30, 1969

OBJECTIVES: To demonstrate the development and application of improved equipment for solid waste disposal by conducting a study: (1) To determine the requirements for the optimum design of production-scale equipment to compress solid wastes into high-density economical payloads for transport by rail, and to test the operational aspects of such a system. (2) To investigate the potential for utilization of compacted solid wastes as a fill material in lakeshore areas. (3) To explore the potential of multicompaction transfer stations as a means of reducing solid waste collection costs through shorter haul distances. (4) To investigate whether or not the compacted refuse can be placed in a sanitary landfill without causing degradation problems and associated methane gas production.

PROCEDURES: The project is being carried out by personnel of the city of Chicago in conjunction with the Rail-Haul Project Research Team of the American Public Works Association (see Grant No. D01-UI-00073) and consultative services of Northwestern University and Barton-Aschman Associates, Inc.

An experimental baling press approximating a production press in size will be modified and installed in a new building with sufficient auxiliary facilities to carry out a program of tests utilizing synthetic and real refuse samples of varying volumes, contents, and weights. Press modifications and adaptations will be determined and carried out with and by the original press manufacturer. The tests will be made with an evaluation of the results taking place on a running basis.

After about 4 wk of testing, press manufacturers will cooperate to obtain information from the test results, draw their own conclusions for their own design work, and provide the project with their evaluations of the test results. Towards the end of the testing period, officials from states, communities, and disposal areas will be informed in onsite meetings of the project results to obtain their comments and reactions and to maintain appropriate public relations required for acceptance of the rail-haul concept.

As the actual testing program is progressing, test bales will be furnished to Northwestern University where laboratory investigations will be conducted regarding objectives 2 and 4 of the project. As the parameters for the production model press become known, this information will be interpreted by Barton-Aschman and Associates in the attainment of objective 3.

PROGRESS TO DATE: The press has been obtained, modified, and installed for the testing program. The other materials and facilities needed have been brought to the site of the Solid Wastes Research Facility (103rd Street at Doty Avenue), and all is in readiness for the actual tests to begin. The test program is scheduled for January, February, and March 1969. No specific data are yet available.

Engineering evaluation of plastic and paper sacks for increased efficiency of refuse collection

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PROJECT TYPE: STUDY AND INVESTIGATION — **GRANT NO.** D01–UI–00172
GRANTEE: CITY OF INGLEWOOD, CITY HALL, 105 EAST QUEEN, INGLEWOOD, CALIFORNIA 90301
PROJECT DIRECTOR: WILLIAM F. FARNAM, PUBLIC WORKS DIRECTOR, PUBLIC WORKS DEPARTMENT,
CITY OF INGLEWOOD, INGLEWOOD, CALIFORNIA 90301

ESTIMATED TOTAL PROJECT COST:	$127,050
GRANTEE'S SHARE:	$ 42,420
FEDERAL SHARE:	$ 44,205 [01]
(BY YEAR OF PROJECT LIFE)	$ 40,405 [02]

DATE PROJECT STARTED: JUNE 1, 1968 — **DATE PROJECT ENDS:** MAY 31, 1970

OBJECTIVES: To make a comprehensive evaluation of available plastic and paper sack materials and appurtenances to determine their overall suitability for use as solid waste containers.

PROCEDURES: The project is being conducted by the consulting engineering firm of Ralph Stone & Company, Inc., Engineers, Los Angeles, California.

Major elements of the project will be:

1. Evaluation of the effect of disposable containers on solid waste collection efficiency. Field surveys using alternative types of sacks will be conducted in representative areas within the city of Inglewood. Other representative areas will be selected to provide control information so that the effect of sacks on collection efficiency and other related factors can be determined. Plastic and paper sacks will be distributed to approximately 1,000 homes for a period of 6 mo while these surveys are being conducted.

2. A comparative evaluation between the use of plastic and paper sacks for solid waste containers. This will involve laboratory tests on various plastic and paper sack materials to determine performance criteria and develop a specification for the purchase of refuse sacks.

3. To study and report on public preferences in the use of disposable containers versus metallic containers. Public information surveys will be conducted to determine the attitude of Inglewood's citizens to existing refuse collection operations and procedures, and how the use of sacks may have altered these attitudes.

4. To devise methods and procedures to provide incentives for use of superior containers.

5. Investigation of environmental health and safety aspects of the use of disposable containers.

6. To study and recommend alternative methods of distributing bags and holders to householders. The assistance of local merchants and bag distributors will be enlisted in devising alternative feasible methods for bag distributions to the citizens of Inglewood on a large-scale basis, pending the satisfactory results of the field studies.

7. To evaluate the use of bags in bins and large container systems.

8. To conduct an extensive public relations program within the city to acquaint the citizens with the objectives and procedures of the project activities.

PROGRESS TO DATE: Initial work activities involved the conduct of several weeks of field surveys to define representative areas in the city of Inglewood for eventual participation in the pilot studies. A total of six areas were chosen, each of which had physical boundaries approximately equal to an existing refuse collection route. Each of the six study areas is composed of approximately 300 homes or apartment units. Four of the areas are located in lower to middle income single family residential areas. The final two areas are predominately composed of apartment house units.

Of the six areas, three were selected to receive bags for test use. The remaining three areas were designated as control areas to provide the necessary control on the collection operations following the distribution of bags so that detailed and valid estimates can be made of the potential collection cost savings derived through the use of the bags. The field studies conducted in the pilot and control study areas included the determination of the type of residence, the lot widths, the numbers and types of refuse containers placed for collection, the type and percent composition of the refuse placed for collection, and other related factors. Additionally, the six crews and collection vehicles chosen for participation in the study will be used throughout the study period. These crews were given detailed evaluation during the field surveys. Evaluation included the collection time per stop, the collection time based on various types and numbers of containers at the collection stop, the time for driving between collection stops, the density of refuse achieved within the collection vehicle, and other factors. Statistical evaluation of the field data has been completed and performance curves prepared for the various crews. Upon the initiation of the field studies involving the use of the bags, the performance of these crews can be compared on a valid basis with their performance using the conventional container system. Field measurements and results will be given added validity through the conduct of time and motion analysis using method—time—measurement techniques.

Laboratory tests on bagging materials submitted by manufacturers have been completed. These involved the determination of the effect of various typical refuse constituents as well as moisture on the strength of the various bagging materials. Tensile, abrasion, and puncture tests were also conducted. A specification for the purchase of bags for use during the pilot studies is now in draft form.

A questionnaire has been developed for eventual distribution to the householders participating in the study to determine the attitude of the resident to the existing refuse collection operations and to determine potential areas for refuse collection improvement in Inglewood. The questionnaire is designed to evaluate the improvements in service provided through the use of the bag, if any, and also to indicate where the citizen feels improvements in refuse collection service are needed and which of these he regards as being the most important at this time.

Several implementation procedures are being given preliminary consideration in the event that the use of the bags in the city of Inglewood is found to be desirable.

Development of a solid waste disposal plan and program integrated with the comprehensive regional planning process

PROJECT TYPE: DEMONSTRATION **GRANT NO.** D01–UI–00174
GRANTEE: REGIONAL PLANNING COUNCIL, 701 ST. PAUL STREET, BALTIMORE, MARYLAND 21202
PROJECT DIRECTOR: ROBERT N. YOUNG, EXECUTIVE DIRECTOR, REGIONAL PLANNING COUNCIL

ESTIMATED TOTAL PROJECT COST:	$178,279
GRANTEE'S SHARE:	$ 59,426
FEDERAL SHARE:	$ 34,003 [01]
(BY YEAR OF PROJECT LIFE)	$ 42,683 [02]
	$ 42,167 [03]

DATE PROJECT STARTED: JUNE 1, 1968 **DATE PROJECT ENDS:** MAY 31, 1971

OBJECTIVES: To demonstrate how new or improved solid waste management techniques could solve a regional solid waste problem by developing a solid waste disposal plan and program and management advisory procedures for the Baltimore metropolitan area and by integrating these with the continuing comprehensive regional planning process and with State and local solid waste disposal planning activities.

PROCEDURES: The project is being conducted by staff of the Regional Planning Council, with the participation of governmental units in the Baltimore metropolitan area. The demonstration will be carried out in three phases, each of which is expected to take about a year.

Phase I. This phase will be primarily devoted to considerations associated with solid waste disposal. Several alternative plans for sets of disposal sites, employing various disposal methods, will be developed, along with estimates of the cost of each. Major work elements will include identifying existing collection and disposal systems and obtaining information about new and improved technologies for waste disposal and treatment of wastes before disposal.

Special studies will include the development of cost estimates for a system of compressing, baling, and packaging refuse for shipment to a site remote from the urban area. Other special studies will be undertaken to aid local governments in evaluating disposal technologies and selecting sites for needed disposal facilities. The possibility of a computer-oriented systems analysis study of solid waste collection and transport will be explored by personnel of Johns Hopkins University.

Phase II. Seasonal variations in the quantity and characteristics of solid wastes produced in the study area will be investigated. Federal, State, and local laws governing solid wastes will be compiled. Sources of junked automobiles, appliances, etc., and costs of solid waste collection, transport, and disposal will be determined. With the use of the various disposal plans developed in Phase I, the major effort in this phase will be to develop, by computer, an optimized collection and disposal system for the region.

Phase III. The computer simulation evaluation will continue into this phase. Other major work items will include administrative and legal studies and development of recommendations for implementation of the regional plan and for implementation of a public education and information program.

PROGRESS TO DATE: The grantee has provided the following statement concerning progress on the project:

Because of previous personnel commitments to other projects completed in September 1968, major emphasis in the early months of this project has been placed on the systems analysis activities.

Staff professionals began devoting full time to this phase of the project as soon as they became available.

Accomplishments include obtaining the solid wastes transport program from Johns Hopkins University and assuring that it could operate on a computer available to the Regional Planning Council (RPC). Other peripheral programs have been developed for use on the time-sharing GE-265 computer at the remote terminal in the RPC offices. One of these programs will convert data from the RPC format for 645 transportation zones to a format ready for punching for the Hopkins program, which is run on an IBM 7094.

The other program assembles transportation zones into collection routes of appropriate size for the Hopkins model and obtains its input data from the first program for the transportation zones designated as tributary to a particular disposal facility.

In reviewing literature and in discussions with other professionals, a staff member hit upon the idea of using a standard transportation model, with minor modifications, to designate the service areas in which transportation costs are least for any given configuration of disposal sites. Traditionally this program has been used to optimize a transportation system for a group of diverse manufacturing locations and various demands (customer). The use of this model will reduce computer runs for a given disposal plan to one. With the Hopkins model, the service areas would be assumed and "optimization" would be by trial and error. This will permit evaluation of more possible disposal plans, which we feel is highly desirable. The Hopkins model will be then used for a more detailed analysis of the three or four most attractive possibilities, and for comparison, evaluation of at least one plan for a non-regional configuration (service areas not crossing jurisdictional boundaries).

Other activities have included organization of a Technical Advisory Committee for this study. The first meeting was held on Dec. 2, 1968. Interest and response have been extremely good, and much insight into the diverse problems of the operation of a solid wastes disposal system was gained from these operating personnel and representatives of other concerned agencies and organizations. Necessary contracts have been developed and reviewed and approved as required by Maryland.

Coordination with the State Health Department has been the first step in beginning data collection on the existing system. A meeting was held with the Health Department to determine which data they have collected that would be of use to us and to avoid duplication of effort. The Health Department is, of course, represented on the advisory committee.

Many additional minor and major problems identified within the scope of this grant by the advisory committee will be studied on a priority basis to the extent that the allocated resources allow. Among others, they include the need for uniformity of data collection and suggestions on data that should (and shouldn't) be collected, current fate of waste oil in the region, handling of demolition debris, dead animals and diseased trees.

Local interests concerned with rail transport of wastes, barging to sea, and baling have been partially identified and will be contacted in the near future for more detailed information. Appointments with the individual local disposal facility operators have been and are being made for early 1969. It is anticipated that the first round of interviews should be completed by the end of January or mid-February. Review of technology locally with consultants and others will help identify necessary contacts and permit arrangements for necessary site visits to begin by late winter or early spring.

Use of prepared refuse with coal in large utility boilers

PROJECT TYPE: STUDY AND INVESTIGATION GRANT NO. D01-UI-00176
GRANTEE: CITY OF ST. LOUIS, CITY HALL, ST. LOUIS, MISSOURI 63103
PROJECT DIRECTOR: G. WAYNE SUTTERFIELD, COMMISSIONER OF REFUSE COLLECTION AND DISPOSAL,
4100 SOUTH FIRST STREET, ST. LOUIS, MISSOURI 63118
ESTIMATED TOTAL PROJECT COST: $60,000
GRANTEE'S SHARE: $20,000
FEDERAL SHARE: $40,000 (01)
(BY YEAR OF PROJECT LIFE)
DATE PROJECT STARTED: JUNE 1, 1968 DATE PROJECT ENDS: MAY 31, 1969

OBJECTIVES: To evaluate the feasibility of a proposed new method of solid waste disposal that consists of blending controlled percentages of properly prepared municipal refuse with coal for use as fuel in large coal-fired boiler plants.

PROCEDURES: The consulting engineering firm of Horner & Shifrin, Inc., St. Louis, Missouri will conduct the study. Union Electric Company, St. Louis, will assist, in an advisory capacity, in determining the economic and engineering feasibility of the proposed process.

The following items will be considered in detail to determine the physical feasibility of the proposed process: (1) necessary degree of preparation of the refuse for blending with coal and the facilities required; (2) percentage of refuse that can be used as fuel and the heat value thereof; (3) types of boilers applicable to the proposed process; (4) optimum percentage of prepared refuse in fuel mixture; (5) combustion air requirements; (6) disposal of portion of refuse not suitable for use as fuel; and (7) evaluation of problems in storage and transport of prepared refuse and problems attendant to fuel blending.

The relative economic aspects of the proposed process will require evaluation of the effects on the operations of the involved municipal corporation, as well as on those of the utility company. Capital costs of refuse preparation, storage, and transport facilities will be estimated, as well as capital costs of necessary facilities at existing or new boiler plants. Corresponding operation and maintenance costs will be estimated. The foregoing costs will be converted into applicable units for comparison with the costs of other methods of refuse disposal.

Potential long-range problems will be considered on a preliminary basis. Among the matters deserving particular consideration are the possibilities of slagging, corrosion, erosion, boiler tube deposits, unusual difficulties with milling and firing apparatus, and effects on air pollution control equipment.

Public health aspects of handling and storage of the solid wastes will be considered. These will include precautions necessary in design and operation to minimize nuisances and health hazards due to dust, odors, blowing paper, insect propagation, rodents, and effects on air pollution.

Potential benefits of the proposed process to the community will be evaluated, and community–utility relationships and responsibilities in any full-scale application of the process will be considered.

PROGRESS TO DATE: Information is being developed concerning the various types of existing Union Electric Company facilities to evaluate their potential for burning a percentage of prepared refuse with other fuel. Data also are being accumulated from the literature regarding fuel values of prepared refuse, as well as the amounts and characteristics of refuse combustion products and their potential interference with boiler operation. Other investigations are under way on the types and sizes of equipment necessary to properly prepare refuse for firing, as well as on the various feasible methods of transporting and storing prepared refuse.

In evaluating the existing Union Electric system, consideration is being given mainly to the larger facilities. These might consume enough prepared refuse to appreciably assist in alleviating a major refuse disposal problem, while substantially reducing consumption of natural fuel. As a tentative conclusion, it presently appears that a corner-fired boiler, burning pulverized coal, shows the greatest promise of accepting prepared refuse as a portion of the fuel without entailing major modifications to an existing boiler or without creating unacceptable operating problems.

Comprehensive solid waste management in a rural county (clean and green—Chilton County, Alabama)

PROJECT TYPE: DEMONSTRATION GRANT NO. D01-UI-00178

GRANTEE: BOARD OF REVENUE AND CONTROL OF CHILTON COUNTY, ALABAMA, COURT HOUSE,
CLANTON, ALABAMA 35045

PROJECT DIRECTOR: ROBERT M. ALEXANDER, COUNTY ENGINEER'S OFFICE, AIRPORT ROAD,
CLANTON, ALABAMA 35045

ESTIMATED TOTAL PROJECT COST:	$296,375
GRANTEE'S SHARE:	$106,775
FEDERAL SHARE:	$124,680 [01]
(BY YEAR OF PROJECT LIFE)	$ 32,260 [02]
	$ 32,660 [03]

DATE PROJECT STARTED: JUNE 1, 1968 DATE PROJECT ENDS: MAY 31, 1971

OBJECTIVES: To demonstrate how improved management techniques can solve the solid waste problems of a predominantly rural county by providing countywide collection of municipal and rural solid wastes for disposal at a single, centrally located sanitary landfill.

PROCEDURES: Chilton County will establish a sanitary landfill for the disposal of all solid wastes generated in the county. All existing open dumps, some 40 to 50 in number, will be closed.

The county will provide collection services for the rural population by means of a containerized storage and collection system. A study of population distribution and solid waste production in the county will be conducted to select locations for the roadside placement of covered waste receptacles and to select optimal routes to those locations. Twice-a-week collection from the containers will be scheduled. A public education program will be carried out to acquaint the rural population with the system and explain its use. The four municipalities in the county will continue their present collection services, but the collected wastes will be brought to the county landfill for disposal.

Consultant services provided by personnel from the University of Alabama under the direction of Dr. James V. Walters, will include studies of municipal collection procedures to ascertain what improvements can be made.

Records will be kept to evaluate the efficiency and technical success of the program. An environmental sanitation resurvey will be made near the end of the second year of the project, and results will be compared with a similar survey made before the project was initiated. Improvements in sanitary conditions will be evaluated. Concurrently, the consultant will resurvey municipal collection methods to evaluate effects of improved methods implemented as a result of his initial survey. During the final year of the project, a topographic map of the site as altered by the landfill operation will be prepared. Possible uses for the reclaimed area will be determined, and value of the altered site will be estimated.

PROGRESS TO DATE: During the first 3 mo of the project, the landfill site was surveyed and prepared. Specifications for the day-to-day operation of the landfill were developed. Equipment was ordered and delivered including a D-7 Caterpillar tractor for the landfill, and a 30-cu-yd packer truck and 60 four-cu-yd containers for the rural collection system.

The landfill operations began in September 1968; however, installation of scales was not completed until December 1968. Shortly after the landfill opened, the municipalities closed their open burning dumps, instituted rat eradication programs at these sites, and began covering them with clean dirt.

The rural collection system is to be started in January 1969 on county roads and approval is being sought from the State Highway Department and the Bureau of Public Roads for placement of containers on other public roads.

Study and investigation of solid wastes in the Charleston, West Virginia, standard metropolitan statistical area and Kanawha County, West Virginia

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PROJECT TYPE: STUDY AND INVESTIGATION GRANT NO. D01-UI-00186

GRANTEE: REGIONAL DEVELOPMENT AUTHORITY OF CHARLESTON—KANAWHA COUNTY,
WEST VIRGINIA METROPOLITAN REGION, 408 KANAWHA BOULEVARD EAST,
CHARLESTON, WEST VIRGINIA 25301

PROJECT DIRECTOR: JAMES HODGES, SOLID WASTES COORDINATOR, REGIONAL DEVELOPMENT AUTHORITY OF CHARLESTON—KANAWHA COUNTY, WEST VIRGINIA METROPOLITAN REGION

ESTIMATED TOTAL PROJECT COST:	$60,176
GRANTEE'S SHARE:	$20,176
FEDERAL SHARE:	$40,000 [01]
(BY YEAR OF PROJECT LIFE)	

DATE PROJECT STARTED: JUNE 1, 1968 DATE PROJECT ENDS: MAY 31, 1969

OBJECTIVES: To demonstrate how new or improved solid waste management techniques could solve a regional solid waste problem by developing a management program for the Charleston–Kanawha County metropolitan region.

PROCEDURES: The consulting engineering firm of Kelly, Gidley, Staub, & Blair, Inc., Charleston, West Virginia, is performing the technical phases of the work.

Available data concerning solid waste generation in the study area will be reviewed. Information will be obtained relative to projections of population, industrial and commercial development, land use and transportation plans, and an analysis made of present and anticipated future service demands. Existing solid waste collection and disposal facilities will be analyzed, and costs of collection, transportation, and disposal will be developed. Alternate methods of disposal will be compared and possible disposal sites identified. Preliminary designs and costs estimates for a regional system will be prepared, with recommendations for the legislation required and the financing of the proposed system.

PROGRESS TO DATE: Studies of existing municipal records, ordinances, and disposal sites have been completed. Private haulers are cooperating in the study by furnishing data concerning number of employees, equipment used, and area served. Estimates of amounts of solid wastes handled by private haulers are being developed by weighing solid wastes received at a number of different private disposal sites over 2-wk periods. Incinerator records of the city are being reviewed to develop estimates of amounts of municipal refuse generated in the Charleston area. A sampling program is being conducted to determine the composition of the municipal solid wastes.

The 14 major industries in the area are members of a Pollution Advisory Committee, and questionnaire survey forms with reference to industrial solid wastes are submitted to specific industries through this committee. Studies of existing conditions are nearing completion, and future work will be directed toward planning a feasible area-wide collection and disposal system.

Processing of bulky, metallic solid wastes

PROJECT TYPE: STUDY AND INVESTIGATION **GRANT NO. D01-UI-00187**
GRANTEE: MARYLAND STATE DEPARTMENT OF HEALTH, 301 W. PRESTON STREET,
BALTIMORE, MARYLAND 21201
PROJECT DIRECTOR: WILFRED H. SHIELDS, JR., CHIEF, DIVISION OF SOLID WASTES, MARYLAND STATE
DEPARTMENT OF HEALTH, 2305 N. CHARLES STREET, BALTIMORE, MARYLAND 21218

ESTIMATED TOTAL PROJECT COST:	**$42,915**
GRANTEE'S SHARE:	**$14,305**
FEDERAL SHARE: **(BY YEAR OF PROJECT LIFE)**	**$28,610 [01]**

DATE PROJECT STARTED: JUNE 1, 1968 **DATE PROJECT ENDS: MAY 31, 1969**

OBJECTIVES: To investigate the practicality of an improved solid waste disposal method that would eliminate automobile graveyards and junkyards by determining the economic feasibility of operating a central facility to receive discarded vehicles and other junk material such as appliances and machinery; immediately break them into their components; and move them either to scrap processing yards, to storage for later use in the economic cycle, to a warehouse of spare parts, or to solid waste disposal facilities.

PROCEDURES: The detailed study is being conducted by the consulting firm of Management Technology, Inc., Washington, D. C.

An analysis of the extent of the junk problem will be made through research of Federal, State, and local government data, reviews with salvage yard operators, processors, and scrap metal dealers, and by an evaluation of selected urban areas. Current practices and trends in collecting, storing, processing, salvaging, and disposing of these bulky items will be determined. Methods for locating junk-receiving yards will be investigated, and quantity and distribution of this type of solid waste, land use plans, needed facilities, and legislative requirements will be considered.

A systems model will be developed for the procedures and costs of processing the junk items from generation source, through receiving yard, to ultimate destination. This will include the development of methods for transporting the junk items to the receiving yard, the development of a management systems model for the operation of a pilot demonstration program, and the determination of the destination of the materials as they leave the processing facility. A plan of action for implementation of a pilot demonstration project will be developed.

PROGRESS TO DATE: The consultant has considered the abandoning, collecting, storing, disposing, salvaging, and processing of junk cars as an integrated system. Each component of such a system has been analyzed and various problem areas identified. Information about each component of the system was collected from Federal, State, and local governments, from auto dismantlers, steelmakers, and scrap processors, and from other available sources, including trade associations, other States, and reports of other consulting firms. The magnitude of the problems in Maryland was assessed through the use of a questionnaire responded to by all the counties of Maryland and the city of Baltimore, through interviews with State and local officials, and through projections of the future number and distribution of junk cars in the State.

Based upon the data collected, alternative approaches to each problem were evaluated. In this evaluation, all alternatives, based on both technological changes in the private sector and suggested government actions, were analyzed to determine the effect of each on all problems and components of the system.

The consultant is preparing his final report, which contains details of the study and its findings and sets forth his conclusions and recommendations.

PUBLICATION:

MANAGEMENT TECHNOLOGY INC. Automobile scrapping processes and needs for Maryland; a final report on a solid waste demonstration. Public Health Service Publication No. 2027. Washington, U.S. Government Printing Office, 1970. (In press.)

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Public Health Service

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